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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 20907 and 20930.

20684 (CEA-BIB-171) SEPARATION AND DETERMINATION OF TRANSURANIUM ELEMENTS. Hafez, Mohamed Badreldin; Patti, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 48p. (In French). Dep. CFSTI (U. S. Sales Only).

Separation methods for Np, Pu, and actinide elements based on solvent extraction, ion exchange, paper chromatography, coprecipitation, volatilization, and nuclear recoil are reviewed in the first part of the report. In the second part, analytical methods for transuranium elements are related. (France)

Chemical and Spectral Procedures

Refer also to abstracts 20742, 20781, 20819, 20866, 21531, and 21532.

20685 (LA-DC-10556) COMPUTER CALCULATIONS IN SPECTROCHEMICAL ANALYSIS. Phillips, John R.; Murphy, James F.; Martell, Calvin J. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 19p. (CONF-691037-1). Dep. CFSTI.

From Pacific Conference on Chemistry and Spectroscopy, Anaheim, Calif.

A computer in Fortran IV is described; it calculates the concentration of impurities in plutonium and uranium from either optical density or percent transmittance data obtained from a spectrogram of the samples. A second Fortran IV program is used for a complete emulsion calibration. (M.C.G.)

20686 (NP-tr-1879) ISOTOPIC ANALYSIS OF ^{15}N-LABELLED NITRATES. Lantelme, F.; Chemla, M. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Bull. Soc. Chim. Fr.; No. 4, 1314-15 (1968). 5p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 22: 33291.

20687 (RMO-3008) HANDBOOK OF ANALYTICAL PROCEDURES. Latimer, J. N.; Bush, W. E.; Higgins, L. J.; Shay, R. S. (comps. and eds.) (Pitkin (Lucius) Inc., Grand Junction, Colo. Western Uranium Project). 16 Feb 1970. Contract AT(05-1)-912. 291p. Dep. CFSTI.

[This report is a composite of RMO-3001; RMO-3001, Rev. No. 1; Supplement to RMO-3001, Rev. No. 1; and Supplement No. 2 to RMO-3001, Rev. No. 1].

The handbook was compiled for use by the analysts in the laboratory of the USAEC Grand Junction Office, operated by Lucius Pitkin, Inc., as service contractor at Grand Junction, Colo. It is a composite of four earlier publications, RMO-3001; RMO-3001, Rev. No. 1; Supplement to RMO-3001, Rev. No. 1; and Supplement No. 2 to RMO-3001, Rev. No. 1. Alternate methods for analysis that are used as circumstance demands are included. The methods are listed in alphabetical order, according to element, in the table of contents. The procedures are presented in a simple and concise manner, but in sufficient detail to make them readily usable. References and acknowledgements are given in individual sections and procedures for further study, if desired. It is not inferred that the procedures in this manual are universal for any type of sample but have been found very reliable for the types of samples mentioned. (P.C.H.)

20688 TRITRIMETRIC DETERMINATION OF RUTHENIUM IN HYDROCHLORIC ACID SOLUTIONS BY PREREDUCTION WITH EXCESS IRON(II). Potts, Lawrence W.; Lingane, Peter James (Univ. of Minnesota, Minneapolis). Anal. Chem.; 42: 533-4(Apr 1970).

It is demonstrated that ruthenium in HCl solutions can be determined accurately and conveniently by oxidation with chlorine, reduction of Ru^{4+} to Ru^{3+} with excess Fe(II), and titration of the Fe (III) so generated with an appropriate reducing agent. This method requires prior separation of the ruthenium. (M.C.G.)

20689 IODOMETRIC DETERMINATION OF TELLURIUM(VI) IN THE PRESENCE OF TELLURIUM(IV) AND SELENIUM(VI). Beyak, Richard; Jaselskis, Bruno (Loyola Univ., Chicago). Anal. Chem.; 42: 518-20(Apr 1970).

The method depends on the quantitative reduction of tellurium (VI) to tellurium(IV) by iodide ion and on the unreactivity of tellurium(IV) and selenium(VI). Experimental conditions are reported for iodometric reduction of tellurium(VI) in a citric acid buffer. (M.C.G.)

20690 NONIONIC SURFACTANTS AS POLAROGRAPHIC MAXIMUM SUPPRESSORS. Malik, Wahid U.; Chand, Puran (Univ. of Roorkee, India). Anal. Chem.; 42: 515-16(Apr. 1970).

Studies were made on the effect of Nonidet P40, P42, and Nonex 501 with Triton X-100 on the maxima of a number of simple and complex metal ions and on the electrocapillary curves. The ions studied were Pb^{2+}, Ni^{2+}, Co^{2+}, Cd^{2+}, Cu^{2+}, U^{6+}, Mn^{2+}, and Zn^{2+}. (M.C.G.)

20691 ANALYTICAL SEPARATION AND ANALYSIS OF A MULTICOMPONENT SYSTEM BY ELECTRON PARAMAGNETIC RESONANCE. Guilbault, G. G.; Moyer, E. S. (Louisiana State Univ., New Orleans). Anal. Chem.; 42: 441-3(Apr 1970).

A procedure for the separation and quantitative determination of Fe(III), Cu(II), VO^{2+}, Mn(II), Cr(III), and Gd(III) was completed. The method is based on the linear relationship between the first derivative absorption curve intensity and the concentration of the metal ion present in solution. The separation of these ions was accomplished by using either ion selective complexation reagents that can be extracted into organic solvents, or by the selective precipitation of the ions. Procedures were found that produced species exhibiting narrow EPR signals with excellent analytical response over a relatively wide range of concentrations. Calibration curves were prepared for these ions and good reproducibility (±0.4 to 0.6%) with an accuracy of about 4% was obtained. (auth)

20692 REACTIONS OF URANIUM COMPOUNDS WITH RONGALITE (FORMALDEHYDE SODIUM SULFOXYLATE). Grinberg, A. A.; Marshak, E. M. Zh. Neorg. Khim.; 15: 152-4(Jan 1970). (In Russian).

It was established that in the reactions of U(VI) with Rongalite (formaldehyde sodium sulfoxylate) the latter is oxidized to sulfite. Excess Rongalite in reactions with microquantities of reduced U underwent partial oxidation to sulfate. A method for the determination of U(VI) in the presence of H_2SO_3 is proposed. (tr-auth)

20693 AN AUTOMATED METHOD FOR THE DETERMINATION OF MOLYBDENUM IN GEOLOGICAL AND BIOLOGICAL SAMPLES. Fuge, R. (University Coll. of Wales, Aberystwyth). Analyst; 95: 171-6(Feb 1970).

A Technicon AutoAnalyzer is used for the colorimetric determination of molybdenum on the basis of its catalytic action on the potassium iodide–hydrogen peroxide reaction. The procedure is sensitive enough to determine 0.2 $\mu g\ l^{-1}$ of molybdenum with no pre-concentration. The method has been applied to the direct determination of the element in marine and fresh waters, milk and plant samples after dry ashing, and standard rock samples after alkaline fusion. Chromate interference can be removed if necessary by evaporation of the sample solution to dryness with hydrogen peroxide. A correction must be applied if vanadium is present in 2-fold excess over molybdenum. Large variations in ionic strength have a marked effect on the determination. (auth) (UK)

20694 MICROBEAMS FOR ANALYSIS. Cookson, John; Poole, Michael (Atomic Energy Research Establishment, Harwell, Eng.). New Sci.; 45: 404-6(26 Feb 1970).

The quantity and position of minute amounts of many elements in the surface of a specimen may be found by probing it with a finely focused electron beam. At Harwell a proton beam is now being used in this way to make more elements detectable with greater sensitivity. The technique is described in detail. (auth)

20695 QUANTITATIVE ELECTRON PROBE MICROANALYSIS: UNCERTAINTY IN THE ATOMIC NUMBER CORRECTION. Heinrich, Kurt F. J.; Yakowitz, Harvey (National Bureau of Standards, Washington, D. C.). Mikrochim. Acta; No. 1, 123-34 (1970).

The atomic number effect in quantitative electron probe microanalysis has been considered from the point of view of error propagation. The results indicate that the chief causes of analysis uncertainty are poorly known electron backscattering factors and mean ionization potential values. Operating variables such as working voltage or x-ray take-off angle cannot be manipulated so as to reduce the effects of the uncertainties. However, the overall analysis uncertainty remains nearly constant over the entire range of working voltages practical for microanalysis. (auth)

20696 A COMBINATION OF THIN-LAYER CHROMATOGRAPHY AND EMISSION SPECTROSCOPY FOR THE MICRODETERMINATION OF ALKALINE EARTH METALS. Frei, R. W.; Stillman, H. (Dalhousie Univ., Halifax, Nova Scotia). Mikrochim. Acta; No. 1, 184-9(1970).

Thin-layer chromatography of alkaline earth metals on cellulose has been modified. After detection of the metal ions with an oxine spray, identification and semiquantitative determination was carried out by liquid emission spectroscopy. The sensitivity of the method is 0.05 ppM for all cations tested. The smallest detectable change in concentration corresponds to about ±5% in a medium concentration range. Analysis errors were below 10%. (auth)

20697 MASS SPECTROMETRIC DETERMINATION OF THE ISOTOPIC RATIOS OF OSMIUM IN THE MICROGRAM RANGE. Meier, H.; Albrecht, W.; Zeitler, G.; Boesche, D.; Hecker, W.; Menge, P.; Ruckdeschel, A.; Unger, E.; Zimmerhackl, E. (Staatliche Forschungsinstitut fuer Geochemie, Bamberg, Ger.). Mikrochim. Acta; No. 1, 109-14(1970). (In German).

A procedure is described that makes it possible to determine the isotope frequencies of osmium in connection with geochronologic questions via the tetroxide in simple focusing mass spectrometers. Osmium losses are excluded to a considerable degree by means of a special arrangement and through controlled vaporization of the tetroxide, so that osmium samples can be investigated mass spectrographically in the microgram range. The procedure may also prove of importance in the isotope dilution analyses of difficultly fusible metals. (auth)

20698 ROTARY SEPARATORY FUNNEL RACK AND SHAKER FOR DETERMINATION OF MOLYBDENUM IN PLANTS AND SOILS. Doran, J. W.; Martens, D. C. (Virginia Polytechnic Inst., Blacksburg). J. Ass. Offic. Anal. Chem.; 53: 228-34(Mar 1970).

A rotary separatory funnel rack and shaker for determination of plant and soil molybdenum are described. The separatory funnel rack allows rotation around a fixed axis as well as shaking of 20 separatory funnels. Utilization of the funnel rack and shaking adapters reduces procedural time for molybdenum analyses by decreasing time of shaking and addition of reagents. (auth)

20699 REACTION OF β-RESORCYLIDENETHIOSEMICARBAZONE WITH NICKEL (II) CATIONS AND ITS USE FOR GRAVIMETRIC DETERMINATION OF NICKEL. Stankoviansky, S.; Carsky, J.; Beno, A. (Komensky Univ., Bratislava). Chem. Zvesti.; 23: 589-96(Aug 1969). (In Czech).

The reactions between β-resorcylidenethiosemicarbazone and nickel(II) salts in acidic medium were studied. The green, water insoluble nickel(II) salt of molecular formula $(C_8H_8N_3O_2S)_2Ni \cdot 6H_2O$ was isolated and analyzed. It was found to be suitable for gravimetric determination of nickel. By the solubility determination of the salt at various acidities it has been ascertained that at optimum pH conditions 5 to 6.5 and 20°C nickel can be determined in 0.1 to 0.5 mg/ml concentration. The determination with 5×10^{-2} M solution of the reagent in acetone is not disturbed by the presence of alkali metals or alkaline earth cations such as NH_4^+, Tl^+, Be^{2+}, Mg^{2+}, Mn(II), Zn(II), B(III), Cr(III), As(III, V), Bi(III), and Th(IV). The presence of Al(III) and Sb(III) is masked with sodium potassium tartrate. Ti(IV) and Zr(IV) is masked with NaF. The conversion ratio is 0.1000 and the determination error was found to be less than ±0.5%. (auth)

20700 KHIMICHESKIE ANALIZY I FORMULY MINERALOV. (Chemical Analysis and Formulas of Minerals). Borneman-Starynkevich, I. D. (ed.). Moscow; Izdatel'stvo Nauka (1969). 136p.

Separate abstracts were prepared for 3 of the 11 papers included. (M.C.G.)

For abstracts of individual papers see: 20701–20703.

20701 PHOTOMETRIC DETERMINATION OF TANTALUM WITH CRYSTAL VIOLET. Bykova, V. S.; Skrizhinskaya, V. I. pp 5-12 of Khimicheskie Analizy i Formuly Mineralov. /Bornenman-Starynkevich, I. D. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

Experimental results of an investigation of the photometric method for determination of tantalum with crystal violet are presented. Optimum conditions for isolation and determination were established. A procedure is proposed that provides good reproduction of results of determination of small amounts of tantalum in standards and in ores. (tr-auth)

20702 APPLICATION OF ANION EXCHANGE TO THE ISOLATION OF TOTAL RARE EARTH ELEMENTS FROM ORES, MINERALS, AND ALLOYS. Varshal, G. M.; Pavlutskaya, V. I.; Shulik, L. S. pp 48-65 of Khimicheskie Analizy i Formuly Mineralov. /Borneman-Starynkevich, I. D. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

A method is proposed for the isolation of micromilligram quantities of total rare earth elements from ores and minerals for subsequent analysis by distributive paper chromatography. Dynamic conditions for the sorption of rare earths on anion exchangers were studied. (tr-auth)

20703 MECHANISM OF SEPARATION OF MIXTURES OF RARE EARTH ELEMENTS BY THE METHOD OF PAPER CHROMATOGRAPHY. Ryabchikov, D. I.; Varshal, G. M.; Senyavich, M. M. pp 66-87 of Khimicheskie Analizy i Formuly Mineralov. /Borneman-Starynkevich, I. D. (ed.). Moscow; Izdatel'stvo Nauka (1969). (In Russian).

Results of a study of the process of chromatographic separation of mixtures of rare earth elements on paper are presented. Extraction and chromatographic experiments were carried out in nitrate, thiocyanate, and thiocyanate–nitrate systems and the effects of cation salting out on the chromatographic process were studied. (tr-auth)

20704 DIRECT TITRIMETRIC DETERMINATION OF SAMARIUM AND NEODYMIUM. Saxena, O. C. (Univ. of Allahabad, India). Microchem. J.; 15: No. 1, 38-41(Mar 1970).

Samarium and neodymium were determined by direct titration against a solution of L-aspartic acid using Xylenol Orange or Alizarin Red S as indicator. The complexes are formed in the ratio of 1 : 3 at different pH values. The range in which samarium and neodymium were estimated varied up to 59.6363×10^{-4} and 28.8540×10^{-4} mg/liter, respectively. Maximum error for samarium and neodymium was 0.6 and 0.8%, respectively. (auth)

20705 NEW DATA ON THE DETERMINATION OF CALCIUM, STRONTIUM, AND BARIUM IONS IN THE PRESENCE OF EACH OTHER. Szekeres, Laszlo (Technological Inst., Budapest). Microchem. J.; 15: No. 1, 66-70(Mar 1970).

The determination of calcium in the presence of strontium is based on the observation that when a solution containing calcium, strontium, and barium ions is added to aqueous ethanolic medium containing magnesium complexonate and sodium sulfate, $BaSO_4$ and $SrSO_4$ are precipitated out, and magnesium ions (equivalent to the amount of Ca^2 ions) are liberated from their complex. The free magnesium ions can be titrated with EDTA. The determination of barium is based on the fact that barium chromate can be precipitated selectively in a medium containing acetic acid, and after filtration of $BaCrO_4$ precipitate, the other two ions can be titrated with EDTA in the presence of magnesium complexonate, and the chromate ions do not interfere with the titration. (auth)

20706 ISOTOPIC ABUNDANCES OF ACTINIDE ELEMENTS IN LUNAR MATERIAL. Fields, Paul R.; Diamond, Herbert; Metta, Donald N.; Stevens, Charles M.; Rokop, Donald J.; More-

land, Parker E. (Argonne National Lab., Ill.). Science; 167: 499-501(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The abundances of uranium and thorium were measured mass spectrometrically as 0.59 ± 0.02 and 2.24 ± 0.06 ppM, respectively, in the fines of Apollo 11 bulk sample. The ratio $^{235}U/^{238}U$ was 0.007258 ± 0.000016, in agreement with terrestrial uranium. The following upper limits were set: $^{236}U/^{238}U \leq 3 \times 10^{-9}$; parts per million of sample, $^{239}Pu \leq 1 \times 10^{-9}$; $^{244}Pu \leq 9 \times 10^{-11}$, and $^{247}Cm \leq 1.25 \times 10^{-10}$. More alpha activity from ^{227}Th and its decay products appeared to be present than would be in equilibrium with the ^{235}U in the sample. The search for other actinide and transactinide nuclides is continuing. (auth)

20707 EMISSION SPECTROGRAPHIC DETERMINATION OF TRACE ELEMENTS IN LUNAR SAMPLES. Annell, Charles; Helz, Armin (Geological Survey, Washington, D. C.). Science; 167: 521-3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Eighteen minor or trace elements were detected and determined by emission spectroscopy. Direct dc arc excitation of powdered samples was used with three variations in the procedure. Thirteen lunar samples consisting of four fine-grained igneous rocks, one medium-grained igneous rock, seven breccias, and one sample of fines were analyzed. The zinc and nickel concentrations in the breccias were approximately one order of magnitude greater than the concentrations of these elements in igneous rocks. (auth)

20708 OXYGEN ISOTOPE FRACTIONATION BETWEEN MINERALS AND AN ESTIMATE OF THE TEMPERATURE OF FORMATION. Onuma, Naoki; Clayton, Robert N.; Mayeda, Toshiko K. (Univ. of Chicago). Science; 167: 536-8(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Oxygen isotopic compositions of separated minerals from three type A and four type B rocks were very uniform. The $\delta^{18}O$ values were plagioclase, 6.20; clinopyroxene, 5.75; ilmenite, 4.45 (parts per thousand relative to Standard Mean Ocean Water). The isotopic distribution corresponded to equilibrium at 1120°C. The isotopic composition of lunar pyroxenes fell within the range for pyroxenes of terrestrial mafic and ultramafic rocks, ordinary chondrites, enstatite chondrites, and enstatite achondrites, but above the range for basaltic achondrites, hypersthene achondrites, and mesosiderites. Glass isolated from the lunar soil had a $\delta^{18}O$ value of 6.2, significantly richer in ^{18}O than the crystalline rock fragments in the soil. (auth)

20709 WATER, HYDROGEN, DEUTERIUM, CARBON, ^{13}C, AND ^{18}O CONTENT OF SELECTED LUNAR MATERIAL. Friedman, Irving (Geological Survey, Denver); O'Neil, James R.; Adami, Lanford H.; Gleason, Jim D.; Hardcastle, Kenneth. Science; 167: 538-40(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The water content of the breccia was 150 to 455 ppM, with a δD from −580 to −870 per mil. Hydrogen gas content was 40 to 53 ppM with a δD of −830 to −970 per mil. The CO_2 was 290 to 418 ppM with $\delta^{13}C$ = + 2.3 to + 5.1 per mil and $\delta^{18}O$ = 14.2 to 19.1 per mil. Non-CO_2 carbon was 22 to 100 ppM, $\delta^{13}C$ = −6.4 to −23.2 per mil. Lunar dust was 810 ppM H_2O (D = 80 ppM) and 188 ppM total carbon ($\delta^{13}C$ = −17.6 per mil). The ^{18}O analyses of whole rocks ranged from 5.8 to 6.2 per mil. The temperature of crystallization of type B rocks was 1100 to 1300°C, based on the oxygen isotope fractionation between coexisting plagioclase and ilmenite. (auth)

20710 CONCENTRATION AND ISOTOPIC COMPOSITION OF CARBON AND SULFUR IN APOLLO 11 LUNAR SAMPLES. Kaplan, I. R.; Smith, J. W. (Univ. of California, Los Angeles). Contract NAS 9-8843. Science; 167: 541-3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The concentration of carbon and sulfur in six samples ranged between 20 to 200 and 650 to 2300 ppM, respectively. Carbon was present in gaseous, volatilizable, and nonvolatile forms, and terrestrial contaminants were recognized. Sulfur appeared to exist only as acid-volatile sulfide. The bulk fines contained a high concentration of carbon and a low concentration of sulfur. They were always enriched in the heavier isotope carbon-13 or sulfur-34. The fine-grained basaltic rocks showed the reverse relation; lowest carbon, highest sulfide concentrations, and no apparent enrichment in heavy isotopes. The breccias were of intermediate composition. (auth)

20711 RARE GASES IN LUNAR SAMPLES: STUDY OF DISTRIBUTION AND VARIATIONS BY A MICROPROBE TECHNIQUE. Kirsten, T.; Steinbrunn, F.; Zaehringer, J. (Max-Planck Institut fuer Kernphysik, Heidelberg). Science; 167: 571-4(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The rare gas distribution in lunar soil, breccias, and rocks was studied with a micro-helium-probe. Gases were concentrated in grain surfaces and originated from solar wind. Helium-4 concentrations of different mineral components varied by more than a factor of 10 apart from individual fluctuations for each type. Also grains with no detectable helium-4 existed. Titanium-rich components had the highest, calcium-rich minerals the lowest concentrations. The solar wind was redistributed by diffusion. Mean gas layer thicknesses were 10, 6, and 5 μm for helium, neon, and argon, respectively. Lithic fragments in breccias contained no solar gases. Glass pitted surfaces of crystalline rocks contained about 10^{-2} cubic centimeters of helium-4 per square centimeter. Etched dust grains clearly showed spallogenic and radiogenic components. The apparent mean exposure age of dust was approximately 500 × 10^6 years, its potassium–argon was approximately 3.5 × 10^9 years. Cavities of crystalline rocks contained helium-4, radiogenic argon, H_2, and N_2. (auth)

Isotopic Procedures

Refer also to abstract 20989.

20712 DETERMINATION OF MICROQUANTITIES OF CESIUM BY THE METHOD OF REPEATED ISOTOPE DILUTION USING CARRIER-FREE ^{137}Cs. Pomerantseva, A. V.; Zimakov, I. E.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow. Scientific Research Inst. of Glass Technology, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 1, 3-7(Jan 1970). (In Russian).

The method of isotope dilution was used for determination of microquantities of cesium. A variation of the method used the carrier-free radioactive isotope. It was established that for the extraction–substoichiometric isolation of cesium from solutions of different concentrations the system dipicrylaminomagnesium–nitrobenzene can be used. The method was developed for determination of ≥1μg/ml of Cs in standard solutions with an average relative error of ≤2.5%. (tr-auth)

Radiometric Procedures

Refer also to abstracts 20850, 20984, 20987, 20988, 20993, and 21542.

20713 (BNL-tr-327) DETERMINATION OF ULTRAMICROQUANTITIES OF ^{226}Ra IN DIFFERENT SUBSTANCES. Pomanskii, A. A.; Severnyi, S. A.; Trifonova, E. P. Translated by J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR); 27: 36-9(1969). 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 45219.

20714 (NLCO-1045) THE DEVELOPMENT OF A URANIUM ISOTOPIC ANALYTICAL PROGRAM AT THE USAEC FEED MATERIALS PRODUCTION CENTER. Ohlinger, Richard D. (National Lead Co. of Ohio, Cincinnati). 14 Aug 1969. Contract AT(30-1)-1156. 48p. (CONF-690926-3). Dep. CFSTI.

From Conference on Mass Spectrometry, Kyoto, Japan.

The isotopic analytical program provides precise assays on a 24-hour basis for ^{235}U concentrations varying from 0.14 to 10% in feed materials, in production materials, and in all residues generated. These isotopic assays are made by gamma spectrometry and by mass spectrometry utilizing eight UF_6 isotope ratio spectrometers and one surface ionization spectrometer. The gamma spectrometric method is used to assay uranium materials with unknown or suspect ^{235}U concentrations. The development of this rapid method and its application as a supplemental method to the mass spectrometric analyses are described briefly. The method employing isotope ratio UF_6 gas mass spectrometers is used to assay the uranium product materials with known ^{235}U levels. Two methods and the facilities for converting U_3O_8 samples to UF_6 are described. Modifications made to the UF_6 spectrometers are also presented. Although the double-standard interpolative assay method of Smith, Shields, and Tabor is used wherever practical, isotopic dilution techniques are also used to assay any uranium hot covered by the range of the UF_6 standards. The concentrations of the minor uranium isotopes are determined with the surface ionization mass spectrometer. Internal and external analytical quality control programs are reviewed. All descriptions of meth-

ods, equipment, and analytical precisions are based on 12 years experience in performing daily isotopic analyses. (auth)

20715 (NLCO-1048) QUANTITATIVE ALPHA SPECTROMETRIC DETERMINATION OF ^{232}U. Humphrey, H. W.; Fritz, K. M. (National Lead Co. of Ohio, Cincinnati). Feb 1970. Contract AT(30-1)-1156. 18p. Dep. CFSTI.

A method was developed for determining the concentration of ^{232}U in uranium materials to a low limit of 10 ppB on a ^{235}U basis with a relative precision of ±28.2% at the 95% confidence level. The method consists of an ethyl acetate extraction followed by a measurement of the 5.298-MeV (average weighted value) alpha peak of ^{232}U utilizing a Frisch grid ionization chamber. A mass spectrometric ^{235}U value is then used to determine the $^{232}U/^{235}U$ weight relationship. (auth)

20716 SCINTILLATION COUNTING OF ^{32}P WITHOUT ADDED SCINTILLATOR IN AQUEOUS SOLUTIONS AND ORGANIC SOLVENTS AND ON DRY CHROMATOGRAPHIC MEDIA. Haviland, R. T.; Bieber, L. L. (Michigan State Univ., East Lansing). Anal. Biochem.; 33: 323-34(Feb 1970).

Cherenkov radiation produced by ^{32}P makes possible a convenient and efficient method for determination of ^{32}P in virtually any sample utilizing conventional scintillation counters. Organic solvents provide high absolute efficiencies; the highest efficiency measured, approximately 80%, was obtained with toluene. Approximately 50% absolute efficiency is obtained in aqueous solutions with very little variation when strong acids, bases, or salts are present. Paper and silica gel give similar efficiencies with no liquid present because Cherenkov radiation occurs in polyethylene and in glass. Samples are completely unaltered by the counting. Counting conditions are constant for all samples. The efficiency varies with volume, solution composition, and vial material. Efficiencies relative to water for a wide variety of aqueous solutions and organic solvents were determined. (auth)

20717 RAPID METHOD FOR WET COMBUSTION AND SCINTILLATION COUNTING OF ^{14}C-LABELED ORGANIC MATERIALS. Watson, G. R.; Williams, J. P. (Univ. of Toronto). Anal. Biochem.; 33: 356-65(Feb 1970).

The method described for the determination of the activity of radioactive solids has many advantages over existing methods. First, it is precise and accurate once the counting efficiency is ascertained. Second, it is relatively inexpensive and requires no additional costly apparatus for its use, other than access to a scintillation counter. Most important of all, it is rapid (less than 5 min/sample) and convenient. This method is applicable to any organic material, liquid or solid, which can be combusted to CO_2. In addition, $^{14}CO_2$ from sources other than combustion could be collected in the vial assembly by introduction to the system and circulation till absorbed. The results obtained indicate that recovery of ^{14}C is essentially 100%. (auth)

20718 A COMPARATIVE EVALUATION OF A COMBUSTION METHOD FOR LIQUID SCINTILLATION ASSAY OF ^{14}C AND TRITIUM IN BIOLOGICAL MATERIALS. Huebner, L. G.; Kisielewski, W. E. (Argonne National Lab., Ill.). Atompraxis; 16: 15-18 (Jan-Feb 1970).

An apparatus and technique are described for direct combustion of biological materials. This method offers quantitative collection of carbon dioxide and water for the measurement of ^{14}C and tritium by liquid scintillation counting. It combines the simplicity of oxygen-flask combustion with the efficiency and reproductivity of vacuum-line techniques. Also included is an assembly for direct in-vial collection of the final products of combustion. This facilitates separation and measurement of ^{14}C and tritium in double-labeled samples. Various biological materials, ranging in weight from a few mg to 150 mg, can be combusted and quantitatively recovered. Because products other than water and carbon-dioxide are removed prior to measurement, quenching effects are eliminated. Data are presented on the efficiency, recovery, and quenching of tritium and ^{14}C utilizing the vacuum-line combustion method. The data are also compared to values obtained by the oxygen-flask method. (auth)

20719 BURNUP DETERMINATION OF JRR-3 IRRADIATED FUELS BY DESTRUCTIVE METHODS. Aochi, Tetsuo; Komori, Takuji; Emura, Satoru (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 12: 7-12(Jan 1970). (In Japanese).

After dissolution of the fuels, U was determined by potentiometric titration without separation, and Pu by α counting with correction for isotopic composition. The isotopic composition of U and Pu was measured by mass spectrometry, while Cs was determined by γ spectrometry after separation by coprecipitation. The values of burnup obtained by isotopic analysis covering the thermal fission of ^{235}U and ^{239}Pu and fast fission of ^{238}U are in good agreement with those obtained from $^{137}Cs/U$ measurements. (auth) (NSA of Japan)

20720 A RAPID METHOD FOR THE RADIOCHEMICAL DETERMINATION OF ^{106}Ru IN MARINE ORGANISMS. Iwashima, Kiyoshi (Inst. of Public Health, Tokyo); Koyama, Kanehiro. Koshu Eiseiin Kenkyu Hokoku; 18: No. 1, 17-21(Mar 1969). (In Japanese).

A rapid and simple method is proposed for the determination of ^{106}Ru in seaweed and fish. The isotopic exchange between added ruthenium carrier and radioruthenium in the sample is effected by fusion with a KOH–KNO_3 mixture. In the presence of a buffer solution, ruthenium is extracted as the tetroxide into carbon tetrachloride from an aqueous solution at pH 4. The ruthenium is then back-extracted into a dilute solution of sodium hydroxide, precipitated as the dioxide, mounted, and the beta activity is counted. The chemical yield is estimated colorimetrically on Ru(IV) chloride. The present method can be successfully used for samples containing >1 pCi of ^{106}Ru. Error in the determination of picocurie order is estimated as 10% when the counting time is one hour. A high decontamination from other fission products and some corrosion products is attained, and a consistent chemical yield of more than 80% is obtained. (auth) (NSA of Japan)

20721 POTASSIUM, RUBIDIUM, STRONTIUM, BARIUM, AND RARE-EARTH CONCENTRATIONS IN LUNAR ROCKS AND SEPARATED PHASES. Philpotts, John A.; Schnetzler, C. C. (Goddard Space Flight Center, Greenbelt, Md.). Science; 167: 493-5 (30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Concentrations of potassium, rubidium, strontium, barium, and rare earth elements have been determined by mass spectrometric isotope dilution for eight Apollo 11 lunar samples and for some separated phases. Potassium and rubidium were at chondritic levels, strontium at 15 times, and barium and rare earths at 30 to 100 times chondritic levels. There were trace element similarities between the lunar samples and basaltic achondrites, terrestrial dredge basalts, and the bulk earth. The trace element data appear to be consistent with these lunar samples being the result of limited partial fusion of some material similar to the brecciated eucrite meteorites. (auth)

20722 ALPHA-PARTICLE ACTIVITY OF APOLLO 11 SAMPLES. Richardson, K. A.; McKay, D. S.; Greenwood, W. R.; Foss, T. H. (Manned Spacecraft Center, Houston, Tex.). Science; 167: 516-17(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Nine polished thin sections from Apollo 11 rock samples have been exposed to nuclear track plates, three have been counted by alpha-particle spectrometry, and one has been examined by electron microprobe. Interpretation of the results is in a preliminary stage. Alpha track distribution in the autoradiograph of a breccia formed a network that appeared related to the rims of accretionary lapilli composing the breccia. Thorium in a coarse-grained crystalline rock was concentrated in micron-sized, zirconium-rich crystals. Alpha count rates agreed with what would be predicted from previously reported thorium and uranium contents of the same rocks, suggesting secular equilibrium for the thorium and uranium decay series. (auth)

20723 PATTERN OF BOMBARDMENT-PRODUCED RADIONUCLIDES IN ROCK 10017 AND IN LUNAR SOIL. Shedlovsky, Julian P. (National Center for Atmospheric Research, Boulder, Colo.); Honda, Masatake; Reedy, Robert C.; (and others). Contract NAS 9-7891. Science; 167: 574-6(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

A large number of radionuclides have been measured as a function of depth in lunar rock 10017 and in bulk fines. Data are reported on ^{10}Be, ^{22}Na, ^{26}Al, ^{36}Cl, ^{49}V, ^{53}Mn, ^{54}Mn, ^{55}Fe, ^{56}Co, ^{57}Co, and ^{59}Ni and on upper limits for ^{46}Sc, ^{48}V, ^{51}Cr, and ^{60}Co. The results for several nuclides show striking evidence of excess surface production attributable to solar flare particles. Data for short-lived species, ^{56}Co, ^{57}Co, ^{54}Mn, ^{55}Fe, and ^{22}Na, appear consistent with fluxes from known recent events. Long-lived species demonstrate the existence of solar flare protons and alphas at least for the last 10^5 to 10^6 years, at fluxes comparable to those now observed. (auth)

20724 COSMOGENIC AND PRIMORDIAL RADIONUCLIDES IN LUNAR SAMPLES BY NONDESTRUCTIVE GAMMA-RAY SPECTROMETRY. Perkins, Richard W.; Rancitelli, Louis A.; Cooper, John A.; Kaye, James H.; Wogman, Ned A. (Battelle Memorial Inst., Richland, Wash.). Science; 167: 577-80(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The ^{7}Be, ^{22}Na, ^{26}Al, ^{44}Ti, ^{46}Sc, ^{48}V, ^{51}Cr, ^{54}Mn, ^{56}Co, ^{57}Co, ^{60}Co, ^{40}K, ^{238}U, and ^{232}Th were measured in lunar fines and portions of three rocks. Major production of cosmogenic radionuclides is due to solar protons, thus their concentrations were far different from those in meteorites. Surface exposures of the rocks and fines were long compared with the 0.74 million year half-life of ^{26}Al. Lunar fines showed substantially higher concentrations of low energy reaction products. The ratios of thorium to uranium were extremely constant at 3.8, which indicated very little geochemical differentiation and were in good agreement with a common nucleosynthesis for lunar and earth materials. (auth)

20725 SEPARATION AND DETECTION OF CERIUM FROM RADIOACTIVE FALLOUT BY SOLVENT EXTRACTION METHODS. Suzuki, Toshio; Sotobayashi, Takeshi; Koyama, Seitaro (Niigata Univ., Japan). Nippon Kagaku Zasshi; 91: 68-71(Jan 1970). (In Japanese).

A simple and rapid radiochemical procedure for the determination of Ce activity in radioactive fallout is based on solvent extraction of Ce(IV) with high molecular weight amine and quaternary ammonium salt. The sample was fused with Na_2CO_3 in the usual way. The HCl solution of the melt was evaporated to dryness. After dissolving the residue in 8 N HCl solution, ^{237}U, ^{132}Te, etc., were extracted with 10 vol % tri-n-octylamine in xylene. With the aid of an iron collector, Ce in the aqueous phase was precipitated with NH_3 solution. The precipitate was dissolved in HNO_3 solution, the solution was then adjusted to 6 N HNO_3, and $NaBrO_3$ was added to make the solution 1 mole/l in $NaBrO_3$. Ce was separated from other nuclides by the extraction with 10 vol % quantamin T-08 in (1 : 9) mixture of nitroethane and n-hexane. The Ce-bearing organic phase solution was then scrubbed with 6 N HNO_3 solution. Final purification was carried out by stripping Ce from the organic phase into 6 N HNO_3 solution containing 1 drop of 30% H_2O_2. The evaporation residue of the stripping solution was transferred into a conventional dish for counting. The predominant Ce species extracted in the organic phase was suggested. The present procedure was applied to rain water following French nuclear tests. No detectable amount of radionuclides other than $^{141,144}Ce$ could be found in the γ spectrum of the sample obtained through this production. (auth)

20726 ^{14}C ASSAY AFTER PARR PEROXIDE BOMB FUSION. Ford, Leonard A. (Food and Drug Administration, Washington, D. C.). J. Ass. Offic. Anal. Chem.; 53: 86-8(Jan 1970).

A method has been developed for converting organic ^{14}C compounds to ^{14}C-carbon dioxide and subsequent quantitation by liquid scintillation counting. The sample is converted to sodium carbonate in a Parr bomb. Carbon dioxide is liberated from the fused salt, absorbed in an organic base, and incorporated in a liquid scintillation "cocktail" for radioassay. Some advantages over existing methods in current use are given. (auth)

Activation Procedures

Refer also to abstract 21155.

20727 (MIT-905-154) CHEMISTRY PROGRESS REPORT, DECEMBER 31, 1969. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. 61p. Dep. CFSTI.

Developments are reported for studies on: nuclear chemistry, including radioactive decay and nuclear structure and fission; physical chemistry; earth and environmental sciences; instrumentation; instrumental chemistry; and hot atom chemistry, including ion–molecule reactions. (P.C.H.)

20728 NEUTRON ACTIVATION DETERMINATION OF MACRO AMOUNTS OF TUNGSTEN BY MEANS OF AMPULE SOURCES. Mezhiborskaya, Kh. B.; Krasikova, M. I. Zh. Anal. Khim.; 25: 581-3(Mar 1970). (In Russian).

A neutron activation method is suggested for determining tungsten in macroconcentrations by means of an ampule source. At the intensity of the source of about $n \cdot 10^7$ neutron/sec the determinable concentrations are within the range of 0.5 to 100% absolute, the accuracy is 10 to 3%. The irradiation of the sample proceeds over 1 to 2 days, the measurements take 10 to 30 min. (auth)

20729 NEUTRON ACTIVATION ANALYSIS OF CONTAMINANTS IN CHEMICALS APPLIED IN TELECOMMUNICATION TECHNIQUES. Csath, G.; Oerdoegh, M.; Szabo, E. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem.; 18: 23-9(1970). (In Hungarian).

Methods of the determination of sodium, copper, gold, bromine, and aluminum contamination in some chemicals routinely and extensively used in the telecommunication industry are described. Sodium, copper, and gold impurities are separated by paper chromatography whereas bromine and aluminum are determined after fast irradiation with the use of a pneumatic facility. (auth)

20730 INSTRUMENTAL NEUTRON ACTIVATION ANALYSES OF LUNAR SPECIMENS. Goles, Gordon G.; Osawa, Masumi; Randle, Keith; Beyer, Robert L.; Jerome, Dominique Y.; Lindstrom, David J.; Martin, Marilyn R.; McKay, Shelia M.; Steinborn, Terry L. (Univ. of Oregon, Eugene). Science; 167: 497-9(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Ten Apollo 11 specimens were divided into 24 samples. Sodium contents of 8 diverse specimens cluster tightly about 0.3 percent. Plagioclase separated from sample 10044 contained about 1.09 percent Na; barium was not enriched in the plasioclase separate. Contents of the rare earths were strikingly high, and relative abundances resembled those of calcium-rich achondrites or abyssal basalts but were depleted in Eu by factors of 2 to 3 and in La by about 20 percent. The plagioclase separate was enriched in Eu and pyroxenes and opaque minerals were Eu-depleted. Fine fractions of 10044 were about 20 to 40 percent richer in most rare earths (50 percent for Eu) than coarse fractions, probably because of the presence of small grains in which rare earths were markedly concentrated. "Microgabbro" 10045 was impoverished, relative to the soil, in rare earths and Hf. Ratios by mass of Zr to Hf were comparatively low. Abundances of Mn, Co, Fe, Sc and Cr suggested systematic differences between igneous rocks on one hand and breccias and "soil" on the other. From the Co abundances, no more than about 3 percent of the present "soil" can consist of chondritic meteorite contamination. (auth)

20731 TRACE ELEMENTS AND ACCESSORY MINERALS IN LUNAR SAMPLES. Reed, George W. Jr.; Jovanovic, Stanka; Fuchs, Louis H. (Argonne National Lab., Ill.). Contract T-76356. Science; 167: 501-3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Halogen contents similar to those in meteorites are reported in Apollo 11 samples. Concentrations of 0.6 to 13 parts mercury, 0.2 to 0.8 part uranium, 1 to 17 parts lithium, and 1 to 800 parts osmium per million and 0.5 to 1 percent chromium oxide by weight have been measured. In contrast to meteorites and terrestrial rocks a large mercury release below 110°C was observed. Some implications of these results are presented. Fluorapatite, quartz, tridymite, fayalite, and iron-rich, manganese-poor pyroxmangite, previously unreported, have been identified. The small amount of fluorapatite found did not account for the fluorine contents. (auth)

20732 GALLIUM, GERMANIUM, INDIUM, AND IRIDIUM IN LUNAR SAMPLES. Baedecker, Philip A.; Wasson, John T. (Univ. of California, Los Angeles). Contract NAS 9-8096. Science; 167: 503-5(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Neutron activation analyses of gallium, germanium, indium, and iridium in eight lunar samples and in meteorites and rocks (including four calcium-rich achondrites and five terrestrial basalts) with similar bulk compositions are reported. Lunar gallium concentrations were remarkably constant at about 5 parts per million, three times higher and four times lower than those in eucritic (calcium-rich) achondrites and terrestrial basalts, respectively. Lunar germanium concentrations ranged from ≤0.04 ppM. Basaltic achondrites had similar germanium concentrations, whereas those in terrestrial basalts were uniformly higher at about 1.4 ppM. Concentrations of indium in lunar samples ranged from 3 to 60 ppB, whereas those in terrestrial basalts were 80 to 100 ppB, and those in basaltic achondrites 0.4 to 3 ppB. Lunar iridium concentrations appeared to be in the 0.1 to 10 ppB. The Tranquillitatis samples were distinctly different from calcium-rich achondrites and terrestrial basalts. (auth)

20733 MULTIELEMENT ANALYSIS OF LUNAR SOIL AND ROCKS. Morrison, George H.; Gerard, Jesse T.; Kashuba, A. Thomas; Gangadharam, Eswara V.; Rothenberg, Ann M.; Potter, Noel M.; Miller, Gary B. (Cornell Univ., Ithaca, N. Y.). Science; 167: 505-7(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Results for multielement analysis of lunar soil and of seven rocks returned by Apollo 11 are presented. Sixty-six elements were determined with spark source mass spectrography and neutron activation. U. S. Geological Survey standard W-1 was used as a comparative standard. Results indicate an apparent uniformity of composition among the samples. Comparison with solar, meteoritic, and terrestrial abundances revealed depletion of volatile elements and enrichment of the rare earths titanium, zirconium, yttrium, and hafnium. Although there was an overall

similarity of the lunar material to basaltic achondrites and basalts, the differences suggest detailed geochemical processes special to the history of this material. (auth)

20734 NEUTRON ACTIVATION ANALYSIS OF MILLIGRAM QUANTITIES OF LUNAR ROCKS AND SOILS. Turekian, Karl K.; Kharkar, D. P. (Yale Univ., New Haven). Science; 167: 507-9 (30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

A neutron activation scheme for determining 25 elements in lunar samples weighing 20 milligrams is described and applied to a suite of Apollo 11 lunar materials. Concentrations of titanium, chromium, scandium, tantalum, hafnium, and rare earths were higher than in average basalt, whereas cobalt, nickel, and copper were lower. Chemical variations showed groupings of elements possibly associated with the major phases, pyroxene, plagioclase, and ilmenite. The high concentration of refractory oxides and low volatile content implied that the raw material for the Apollo 11 samples was condensed from the primitive solar nebula at high temperatures. (auth)

20735 ELEMENTAL COMPOSITION OF LUNAR SURFACE MATERIAL. Smales, A. A.; Mapper, D.; Webb, M. S. W.; Webster, R. K.; Wilson, J. D. (Atomic Energy Research Establishment, Harwell, Eng.). Science; 167: 509-12(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Elemental abundances, so far obtained, derived from the analysis of Apollo 11 lunar material are reported. Similarities and differences exist between lunar material, the eucritic achondrites, and the augite achondrite Angra dos Reis, the analysis of which is also reported. (auth)

20736 ABUNDANCES OF 30 ELEMENTS IN LUNAR ROCKS, SOIL, AND CORE SAMPLES. Schmitt, Roman A.; Wakita, Hiroshi; Rey, Plinio (Oregon State Univ., Corvallis). Science; 167: 512-15(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Abundances of 30 elements in seven lunar rocks and soil were determined by instrumental and radiochemical activation analysis. Seven major and minor elements in chips from 27 rocks were determined by instrumental activation analysis. Abundances of ten bulk elements overlapped for the breccia rocks and soil samples. All lunar rare earth elements distribution patterns resembled those found in terrestrial abyssal subalkaline basalt, but with Eu depleted by about 60 percent in all lunar samples compared to the adjacent rare earth elements. Precipitation of plagioclase and hypersthene achondritic-like minerals from a melt could account for Eu depletion and the observed distribution of rare earth elements. Abundances of Ti, Al, Ca, Na, and Mn determined by instrumental activation analysis in five core-tube soil samples indicated uniformity for Al and Mn and apparent differences (10 to 20 percent) for Ti, Ca, and Na at 7.8 and 10.5 centimeters as compared to 0 to 5.2 centimeter depths. (auth)

20737 MAJOR AND TRACE ELEMENTS AND COSMIC-RAY PRODUCED RADIOISOTOPES IN LUNAR SAMPLES. Waenke, H.; Begemann, F.; Vilcsek, E.; Rieder, R.; Teschke, F.; Born, W.; Quijano-Rico, M.; Voshage, H.; Wlotzka, F. (Otto-Hahn Institut, Mainz). Science; 167: 523-5(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Analytical data for 42 major and trace elements were mostly obtained by a combination of instrumental and radiochemical neutron activation analyses using both thermal and 14-MeV neutrons. Excesses of nitrogen and chlorine in the fines, compared with the rocks, were attributed to the solar wind. A striking similarity for contents of seven elements in lunar metal and metal from the calcium-rich achondrite Juvinas was noted. Fractional dissolution was used to separate five radionuclides produced by cosmic-ray bombardment in the fines and rock 57-40. Results for argon-39 from the reaction potassium-39 (n,p), and for argon-37, from the reaction calcium-40 (n,α) seemed to require a neutron spectrum containing more neutrons below 2 MeV than the evaporation spectrum or that given by Arnold, Honda, and Lal (J. Geophys. Res., 66, 3519(1967)) or a strong time dependence for the neutron flux. (auth)

20738 OXYGEN, SILICON, AND ALUMINUM IN LUNAR SAMPLES BY 14 MeV NEUTRON ACTIVATION. Ehmann, William D.; Morgan, John W. (Univ. of Kentucky, Lexington). Contract NAS 9-8017. Science; 167: 528-30(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Abundances of oxygen, silicon, and aluminum in 27 lunar rocks and 3 aliquants of lunar soil have been determined by 14-MeV neutron activation. Mean abundances and standard deviations of individual abundances (in weight percent) within each type are: type A (2 rocks), 38.5 ± 1.2 oxygen, 18.9 ± 0.8 silicon, and 4.0 ± 0.4 aluminum; type B (7 rocks), 39.4 ± 1.0 oxygen, 18.7 ± 0.8 silicon, and 5.0 ± 0.6 aluminum; type C (18 rocks), 41.1 ± 1.0 oxygen, 19.7 ± 0.7 silicon, and 6.6 ± 0.5 aluminum; soil (3 aliquants), 40.8 ± 1.2 oxygen, 20.2 ± 0.2 silicon, and 7.2 ± 0.1 aluminum. Oxygen abundances were lower than those in most common terrestrial rocks and were comparable to those found in certain types of stony meteorites. From these results the lunar soil was most similar to the type C lunar rocks. (auth)

20739 DETERMINATION OF ^{53}Mn BY NEUTRON ACTIVATION AND OTHER MISCELLANEOUS STUDIES ON LUNAR DUST. Herr, W. (Univ., Cologne); Herpers, U.; Hess, B.; Skerra, B.; Woelfle, R. Science; 167: 747-9(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

A highly sensitive determination of spallogenic ^{53}Mn($T = 2 \times 10^6$ yr) was accomplished in 0.99 g of lunar soil. The chemical yield of Mn was determined with carrier-free ^{52}Mn tracer. During a 23-day reactor irradiation the ^{53}Mn is transformed into ^{54}Mn (T = 300 days). Appropriate chemical recycling was done by ion exchange and distillation. Interferences of the (n,p) and the (n,2n) nuclear reactions were carefully studied. A ^{53}Mn disintegration rate of 30.3 ± 5.5 dpm/kg results. This extremely economic method is proposed for further detailed lunar profile measurements. The Re content, which is of possible cosmochemical interest, was determined to be 11 ppB. Appropriate separation techniques were used. The rather weak and complex thermoluminescence properties made a more basic study advisable. Thermogravimetric analysis, mass spectroscopy, and Moessbauer spectroscopy were applied. The presence of ilmenite, metallic Fe, etc., and of an unidentified Fe^{2+}-containing compound was deduced. Natural thermoluminescence could not be proved with certainty in our surface sample. However, the complexity of the artificial thermoluminescence demands better defined mineral fractions. The fission track method was used to measure U distributions in glass spherules, etc. (auth)

20740 DETERMINATION OF FLUORINE IN URINE BY PHOTONUCLEAR-ACTIVATION ANALYSIS. Ohno, S. (National Inst. of Radiological Sciences, Anagawa, Japan); Suzuki, M.; Sasajima, K.; Iwata, S. Analyst; 95: 260-3(Mar 1970).

Before irradiation the fluorine is concentrated by collecting it on an anion exchange resin. The radiochemical procedure for the separation of fluorine-18 from the irradiated resin sample is described. Final purification is achieved by precipitation of fluoride with magnesium chloride. The chemical yield of fluorine is determined by weighing the precipitate after drying. In this method the precision of the observed results in the range 1 to 2 ppM is ±10 per cent and the calculated limit of sensitivity is 0.01 μg. (auth) (UK)

20741 APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO THE DETERMINATION OF COPPER IN MINERALS. Dibbs, H. P. (Dept. of Energy, Mines and Resources, Ottawa). Can. Mining Met. Bull.; 73: 102-8(1970).

An account is given of the application of neutron activation analysis to the rapid, nondestructive determination of copper in minerals, using a 14-MeV neutron source. Elements that interfere in the determination of copper by this method are given, together with the errors in the estimation of copper that result from the presence of varying amounts of these elements. The possible use of a compact sealed-tube 14-MeV neutron generator for the field assay of copper in minerals is discussed. (auth) (Canada)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 20692, 20727, 20866, 21376, 21423, 21548, 21865, and 22509.

20742 (AEC-tr-6981) BIBLIOGRAPHY ON RARE-EARTH ELEMENTS (INCLUDING SCANDIUM AND YTTRIUM) 1958–1962. Mironov, K. E.; Chernikova, L. A. Translation of Redkozemel'nye Elementy (Vklyuchaya Skandii i Ittrii) Bibliograficheskii Ukazatel' (1958–1962 gg)). 426p. (TT-69-55080; IPST-Cat.-5518). Dep. CFSTI.

References (3594) are given to journals, monographs, collections, and abstracts on rare earth elements, scandium, and yttrium published from 1958 to sometime in 1963. Some publications from 1957, abstracts of which were not published before 1958, are also included. The material is divided according to: general research on rare earth elements; atom and crystal structure of metals and rare earth compounds; physical properties of rare earth metals and their alloys; physical properties of compounds of rare earth elements; properties of isotopes of rare earth elements (nuclear cross sections, isotope spectra, decay schemes, etc.); preparation, chemical properties, and reactions of rare earth compounds; analysis of rare earth elements and their compounds; methods of separation and purification of rare earth elements; applications of rare earth elements; and safety techniques. Separate author and subject indexes are included, along with a list of periodicals. (P.C.H.)

20743 (CEA-CONF-1451) SEVERAL EXAMPLES OF PROBLEMS HANDLED AT C.E.A. Caillet, C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1969. 37p. (In French). Dep. CFSTI (U. S. Sales Only).

A very brief survey is given of the types of problems which are habitually resolved on the CEA analog and hybrid computers. The types of problems treated are classified into function-of-time systems, systems independent of time, and the problems of optimization and identification. The simulation studies made on a reactor core and then an entire reactor power plant are described. The study of the functioning of accelerators and plasmas leads to an investigation of the trajectories and energies of an individual particle or of a group of particles and, consequently, to the resolution of differential equation systems or systems with partial derivatives. Two examples are given of the use of computers in chemical and physico-chemical processes—the chlorination of benzene and uranium extraction. Problems of compartments and of identification are computer solved in the areas of biology, medicine, and pharmacodynamics. The use of computers in the study of electronic problems is briefly illustrated. (J.S.R.)

20744 (CEA-R-3943) STUDY OF THE DIFFUSION OF STABLE HYDROGEN ISOTOPES AND OF THEIR ALLOTROPIC FORMS THROUGH A PALLADIUM MEMBRANE. Fitoussi, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1970. 116p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

An experimental device for the continuous measurement of the permeability of palladium to H_2 and D_2 and a technique for the surface treatment of the palladium membrane are described. The permeabilities can be measured with a reproducibility better than 10% for $t < 150°C$ and $p < 100$ mm of mercury. It is shown that surface treatment consisted of air oxidation at 350°C, followed by a reduction in H_2 or D_2 improves the behavior of the membrane towards diffusion. The part played by impurities such as CO and O_2 is reported. It appears from measurements made at $t < 40°C$ that the respective concentrations of the ortho and para varieties in the adsorbed phase and in the gas phase at thermal equilibrium are different. At $t > 0°C$ in the α phase in the presence of H_2 or D_2 enriched in the $J = 0$ variety in the gas phase, the respective ortho–para concentrations remain constant in the adsorbed phase. In the same conditions, but in the β phase, an increase in the concentration of the $J = 0$ variety is observed in the adsorbed phase. In the presence of the Pd membrane, the energy of dissociation of the $J = 0$ varieties is lower than those for which $J = 1$. (France)

20745 (LIB/Trans-251) PREPARATION OF URANIUM HEXAFLUORIDE. Level, A. Translated by P. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Energ. Nucl. (Paris); 6: 225-32(Jun 1964). 18p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original language, appeared as NSA 18: 39389 (1964).

20746 (MLM-1717) DISPROPORTIONATION OF TETRAVALENT AND PENTAVALENT PLUTONIUM IONS: SOME THEORETICAL CONSIDERATIONS. Silver, G. L. (Mound Lab., Miamisburg, Ohio). 26 Mar 1970. Contract AT(33-1)-Gen-53. 27p. Dep. CFSTI.

Plutonium literature does not satisfactorily include the four common oxidation states of plutonium in discussions of the stoichiometry of the disproportionation of the tetravalent and pentavalent states of this element. A theoretical study of possible consequences of including all common oxidation states of plutonium in the disproportionation reactions was made. The study, based upon available potential and free energy data, indicates that the disproportionation equations can be written with all four species included. The potential behavior of disproportionated plutonium solutions can be predicted with the aid of these new equations. The equations also predict that the hydrogen ion dependence of plutonium disproportionation reactions should not be exactly fourth power at all acidities. (auth)

20747 (ORNL-TM-2760) REACTIONS OF IODINE VAPOR WITH ORGANIC PAINT COATINGS. Bennett, R. L.; Slusher, Ruth; Adams, R. E. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 21p. Dep. CFSTI.

An investigation of the reaction of elemental iodine with some paints of interest in the nuclear safety program was conducted. Amercoat 66 and Phenoline 302 paint systems were studied with primary emphasis on the former. Methyl iodide and higher members of the homologous series were produced by the reaction of iodine vapor with either of the two paint systems. As the temperature of the reaction system was increased, the amount of methyl found in the reaction vessel increased significantly. The yield of organic iodides was not significantly changed by the presence of water (100% relative humidity) or hydrogen (0.5%). From the flame ionization chromatographs it was evident that large amounts of organic compounds baked out of the coating on heating. A test simulating an aged coating was conducted by sweeping a heated vessel with nitrogen for one week. While ethyl iodide production was strongly dependent on the concentration of vapors baked from the paint surface, methyl iodide formation was not greatly reduced by removal of the vapors. (auth)

20748 (ORO-3955-1) CRYSTAL STRUCTURE AND MORPHOLOGY OF HYDROUS OXIDES AND HYDROXIDES IN THE LANTHANIDE AND ACTINIDE SERIES. Progress Report. Milligan, W. O. (Baylor Univ., Waco, Tex.). Feb 1970. Contract AT(40-1)-3955. 33p. Dep. CFSTI.

X-ray diffraction studies are being made on precipitated hydrous lanthanide oxides and hydroxides prepared and aged under a variety of conditions. Electron diffraction and electron microscopy studies are being made on the aging of hydrous PuO_2 and on precipitated hydrous oxides and hydroxides of trivalent Cf and Bk. (M.C.G.)

20749 (RFP-Trans-64) PREPARATION AND PROPERTIES OF URANIUM FORMATES. Bressat, Rene; Claudel, Bernard; Navarro, Alain. Translated from Bull. Soc. Chim. Fr.; No. 12, 4807-11(1968). 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 17406.

20750 (UCRL-19507) SOME MAGNETIC, SPECTROSCOPIC, AND CRYSTALLOGRAPHIC PROPERTIES OF BERKELIUM, CALIFORNIUM, AND EINSTEINIUM. Fujita, Dennis Ken (California Univ., Berkeley. Lawrence Radiation Lab.). Nov 1969. Contract W-7405-eng-48. 175p. Dep. CFSTI.

Thesis.

Procedures for the purification, assay, and evaluation of sample purity are discussed for ^{249}Bk, ^{249}Cf, and ^{253}Es. The experimental techniques used to study the magnetic susceptibilities of berkelium metal, Bk^{3+}, and Cf^{3+} are described. The susceptibilities of Bk^{3+} and Cf^{3+} follow the Curie–Weiss relationship with $\mu_{eff}(Bk^{3+}) = 9.40 \pm 0.06\ \mu_B$ and $\mu_{eff}(Cf^{3+}) = 9.14 \pm 0.06\ \mu_B$. Among 3 samples of berkelium metal both ferromagnetism and antiferromagnetism were detected at low temperature; at higher temperatures the susceptibilities follow the Curie–Weiss law. Effective magnetic moments derived from the high-temperature data suggest that greater than 3 electrons per atom occupy bonding orbitals. The effective moment of the most pure Bk metal sample ($8.83\ \mu_B$) corresponds to a metallic valence of ~3.4. A recently developed light-pipe microabsorption cell used to obtain the solution absorption spectra of Bk^{3+} and Es^{3+} in dilute HCl solutions is described. The confirmatory experiments have verified most of the previously detected Bk^{3+} and Es^{3+} absorption peaks. Seven additional Bk^{3+} and 12 new Es^{3+} absorption bands are reported. The most intense Es^{3+} peaks are observed at 4225 Å and 4950 Å. Techniques to prepare several ^{249}Bk, ^{249}Cf, and ^{253}Es compounds on the microgram scale are discussed. Standard x-ray diffraction powder methods are applied in the determinations of the crystal structures and lattice parameters of the Bk and Cf compounds. The extremely high specific radioactivity of ^{253}Es required the development of special techniques for the preparation and x-ray analysis of Es compounds. Face-centered cubic Bk metal ($a = 4.987 \pm 0.001$ Å) is prepared by Li vapor reduction of BkF_3. Attempts to prepare Cf metal by similar reductions of CfF_3 with Li and K were unsuccessful due to the high vapor pressure of elemental Cf. CfF_3 samples exhibiting the orthorhombic YF_3-type structure ($a = 6.651 \pm 0.007$ Å, $b = 7.040 \pm 0.002$ Å, and $c = 4.393 \pm 0.004$ Å) are prepared. The monoclinic lattice constants of $CfBr_3 \cdot 6H_2O$ are $a = 9.992 \pm 0.053$ Å, $b = 6.716 \pm 0.025$ Å, $c = 8.146 \pm 0.006$ Å, and $\beta = 93.50 \pm 0.14$ Å. $CfBr_3$ crystallizes in a structure that remains uncharacterized; however, similar structure has been observed in $BkBr_3$ and $GdBr_3$. CfOBr and CfOI exhibit the

tetragonal PbFCl-type structure. Lattice constants of CfOBr are a = 3.900 ± 0.003 Å and c = 8.110 ± 0.007 Å. CfOI lattice parameters are a = 3.97 ± 0.02 Å and c = 9.13 ± 0.08 Å. Thermal expansion coefficients for CfOCl are reported: $\alpha_a = (1.14 \pm 0.01) \times 10^{-5}°C^{-1}$ and $\alpha_c = (1.85 \pm 0.03) \times 10^{-5}°C^{-1}$. The unsuccessful attempts to prepare $CfCl_2$ by hydrogen reduction of $CfCl_3$ contradict tracer experiments which have been interpreted as evidence for a moderately stable +2 oxidation state of Cf. The first compounds of ^{253}Es are reported. $EsCl_3$ exhibits the hexagonal UCl_3-type structure between 400–450°C; the lattice parameters corrected to 20°C are a = 7.40 ± 0.02 Å and c = 4.07 ± 0.02 Å. EsOCl crystallizes in the tetragonal PbFCl-type structure at 400–450°C. The lattice constants at 20°C are a = 3.948 ± 0.004 Å and c = 6.702 ± 0.019 Å. (auth)

20751 (UCRL–72046) COMPLEXES OF THE RARE EARTH SESQUIOXIDES WITH DIVALENT EUROPIUM OXIDE. Catalano, Edward; Shroyer, Bettie L. (California Univ., Livermore. Lawrence Radiation Lab.); Boo, William O. J. (Mississippi Univ., University. Dept. of Chemistry). [1968]. 5p. (CONF-700403–4). Dep. CFSTI.

From 8th Rare Earth Conference, Reno, Nev.

Eu_3O_4, $EuGd_2O_4$, and $EuDy_2O_4$ are known orthorhombic complexes having interesting cooperative magnetic transitions. Studies were made on the lanthanon sesquioxide–divalent europium oxide complexes to see if a homologous series of orthorhombic stable complexes form. Such a homologous series of complexes would provide valuable magnetic data and also data relating to the stability of the divalent states of lanthanon ions. Results on the preparations and structures of the various complexes are presented. (auth)

20752 COORDINATED POLYMERIZATION OF URANYL FLUORIDE COMPLEXES AT U–F OSCILLATION FREQUENCIES. Vdovenko, V. M.; Dadygin, I. N.; Sugiobov, D. N. Zh. Neorg. Khim.; 15: 265–8(Jan 1970). (In Russian).

The oscillation frequencies of UO_2F_2 bonds were studied by infrared spectra. The ir absorption spectra of the compounds studied were measured in the frequency range 190 to 500 and 800 to 1000 cm^{-1}. Only the bridge bonds of $U-F_M$ were found in the spectra of UO_2F_2 complexes with TBP. However, the ν $(U-F_M)$ was considerably higher than in the spectra of other uranyl compounds $[UO_2F_3]^-$. The results were in good agreement with a more pronounced ^{19}F NMR on the side of weaker fields in UO_2F_2 complexes with TBP as compared to $M[UO_2F_3]$ in previous studies. Thus, the results showed that ir spectra can be used for the determination of the U–F type bonds in UO_2F_2 complexes. The bridge bonds are weaker and are described by lower frequencies valence oscillations of $U-F^{-1}$ in the 270 to 330 cm^{-1} region than in the 350 to 430 cm^{-1} region. (tr-auth)

20753 CHEMISTRY OF PROMETHIUM. VIII. PROMETHIUM (III) MOLYBDATE AND TUNGSTATE. Weigel, F.; Scherer, V. (Univ., Munich. Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Radiochim. Acta; 13: 6–10(Feb 1970). (In German).

Promethium (III) molybdate, $Pm_2(MoO_4)_3$, was obtained by fusing stoichometric mixtures of $C-Pm_2O_3$ and MoO_3 at 950°C. The coral red salt crystallizes in the N-type modification of lanthanide molybdates. The structure may be described in terms of a unit cell derived from Powellite ($CaMoO_4$) or Scheelite ($CaWO_4$). $Pm_2(MoO_4)_3$ is isomorphous with $Nd_2(MoO_4)_3$, but not with $Sm_2(MoO_4)_3$. $Pm_2(WO_4)_3$ was obtained by sintering stoichometric amounts of $C-Pm_2O_3$, and $(NH_4)_2WO_4$ at 950°C, and 20 hr annealing of the reaction product at the same temperature. $Pm_2(WO_4)_3$ is also coral red, and crystallizes in the A-modification of lanthanide tungstate, isomorphous with lanthanide tungstates $Ln_2(WO_4)_3$, where Ln = La ... Nd, and Sm ... Dy. $Nd_2(MoO_4)_3$, $Pm_2(MoO_4)_3$, and $Pm_2(WO_4)_3$ are monoclinic. Their lattice parameters and densities are given. (auth)

20754 URANYL OXALATE COMPOUNDS WITH HYDRAZINE. Volchkov, G. N.; Krylov, E. I.; Sharov, V. A.; Khakhalov, A. A. Zh. Neorg. Khim.; 15: 41–2(Jan 1970). (In Russian).

Methods were developed for the preparation of the compounds $UO_2C_2O_4 \cdot N_2H_4 \cdot 0.75H_2O$ and $UO_2C_2O_4 \cdot 2N_2H_4 \cdot H_2O$. The compounds were studied by x-ray phase and chemical analyses. (tr-auth)

20755 HYDROXYOXALATE COMPOUNDS OF THE URANYL DIOXALATE SERIES. Shchelokov, R. N.; Belomestnykh, V. I. Zh. Neorg. Khim.; 15: 139–46(Jan 1970). (In Russian).

A method is described for the preparation of complexes with the composition $M_n^+[UO_2(C_2O_4)_2(OH)] \cdot nH_2O$, where M and n are Na^+, 1; K^+, 2; $CN_3H_4^+$, 2; $(C2H_5)_2NH_2^+$, 1; and $^1/_2C_2H_4(NH_3)_2^{2+}$, 2; respectively, and also compounds in which M = Cs, n = 2. It was found that the formation of $[UO_2(C_2O_4)_2(OH)]^{3-}$ takes place not only by proton dissociation of aquo groups in $[UO_2(C_2O_4)_2(OH_2)]^{2-}$ but also by substitution reactions of the oxalate group in $[(UO_2)_2(C_2O_4)_5]^{6-}$ and redistribution of hydroxyl groups of dihydroxyuranyl to $[UO_2(C_2O_4)_2(OH_2)]^{2-}$ or $[(UO_2)_2(C_2O_4)_5]^{6-}$ in the presence of saturated oxalate ions in solution and by substitution of hydroxy groups in dihydroxyuranyl by oxalate ions. The structure and mechanism of formation of hydroxydioxalatouranyl ion are discussed. The mechanism of dissolution of dihydroxyuranyl in solutions of alkaline oxalates was also studied. (tr-auth)

20756 HYDROXYTETRAOXALATODIURANYL ION COMPOUNDS. Shchelokov, R. N.; Belomestnykh, V. I. Zh. Neorg. Khim.; 15: 147–51(Jan 1970). (In Russian).

Compounds with the composition $M_n^+[(UO_2)_2(C_2O_4)_4(OH)] \cdot nH_2O$, where M and n are respectively, Na, 4; K, 5; Rb, 2; Cs, 2; and $CN_3H_4^+$, 3 were synthesized and their physicochemical properties studied. The structure of the ion $[(UO_2)_2(C_2O_4)_4(OH)]^{5-}$ was determined. The presence of uranyl pentacoordination was postulated and the mechanism of formation of the previous ion during neutralization process of $[UO_2(C_2O_4)_2(OH)]^{2-}$ and the dissolution of dihydroxyuranyl in alkaline oxalate solutions were studied. (tr-auth)

20757 DETERMINATION OF STABILITY CONSTANTS OF SOME ACTINIDE COMPLEXES. II. NITRATE AND CHLORIDE COMPLEXES OF URANIUM, NEPTUNIUM, PLUTONIUM, AND AMERICIUM. Lahr, H.; Knoch, W. (Technische Univ., Brunswick). Radiochim. Acta; 13: 1–5(Feb 1970). (In German).

Stability constants of the nitrato complexes of several actinides were determined under identical experimental conditions: U(IV), U(VI); Np(IV), Np(V), Np(VI); Pu(III), Pu(IV), Pu(VI); and Am(III). The ionic strength was held constant (μ = 8) by addition of $HClO_4$. A collection of known constants is given for comparison. A systematic relation between cationic radius, ionic charge, and complex strength within a series of actinides of equal valency or different oxidation states of one element could not be established. (auth)

20758 GENERAL ACID CATALYSIS AND THE pH-INDEPENDENT HYDROLYSIS OF 2-(p-NITROPHENOXY)TETRAHYDROPYRAN. Fife, Thomas H.; Brod, Lily H. (Univ. of Southern California, Los Angeles). J. Amer. Chem. Soc.; 92: 1681–4(25 Mar 1970).

The hydrolysis of 2-(p-nitrophenoxy)tetrahydropyran is characterized by a pH-independent reaction at pH values greater than 4.0. This reaction has a D_2O solvent isotope effect of approximately unity; k_{D_2O}/k_{H_2O} = 1.1 for hydrolysis in solvent containing 50% dioxane and k_{D_2O}/k_{H_2O} = 0.9 for hydrolysis in H_2O or D_2O. The value of ΔS^* is +2.2 eu. The pH-independent reaction is strongly accelerated by increasing the polarity of the solvent, being 48.7 times more rapid in water than in 50% dioxane–H_2O. Thus, this reaction is most likely a unimolecular decomposition to p-nitrophenoxide ion and a resonance stabilized carbonium ion. Bond breaking is also relatively important in comparison to protonation in the transition state of the general acid catalyzed reaction as evidenced by the Brønsted coefficient of 0.5 and the positive value of ρ (0.9) obtained in formic acid catalyzed hydrolysis of the series of 2-(substituted phenoxy)tetrahydropyrans. (auth)

20759 SPECTROSCOPIC STUDIES OF ALKALI METAL IONS IN DIMETHYL SULFOXIDE AND 1-METHYL-2-PYRROLIDONE. Wuepper, John L.; Popov, Alexander I. (Michigan State Univ., East Lansing). J. Amer. Chem. Soc.; 92: 1493–6(25 Mar 1970).

The solvation of lithium and sodium ions in dimethyl sulfoxide (DMSO) and 1-methyl-2-pyrrolidone (1M2PY) was studied by the NMR and the far-infrared spectroscopic techniques. Mole ratio study of the $NaAl(But)_4$–DMSO and the $NaAl(But)_4$–1M2PY systems in 1,4-dioxane solutions indicates that the solvation numbers of the Na^+ ion in DMSO and in 1M2PY are 6 and 4, respectively. Infrared spectra of the tetrabutylaluminate and nitrate anions in solutions of these salts as well as the influence of isotope substitution of ^6Li in the lithium salts on the vibration frequency of the far-infrared band are consistent with the view that in the above solvents the anions do not enter into the inner solvation shell of the alkali cations. (auth)

20760 DISPROPORTIONATION OF HEXAVALENT AND THE PREPARATION OF HEPTAVALENT AMERICIUM. Zaitseva, V. P. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 188: 826–9(1 Oct 1969). (In Russian).

The stability of Am(VI) is greatly reduced by lowering the activity of its solution; it was assumed that it disproportionates into Am(V) and Am(VII), although the latter is rapidly reduced. An attempt was made to prepare heptavalent americium by changing the acid solution rapidly into an alkaline one. Solutions of Am(VI) containing either added acid or NaOH were subjected to absorption spectroscopic measurements. On the basis of the results it was concluded that Am(VII) may indeed be prepared by the disproportionation reaction. Addition of 0.3 M potassium persulfate allows fairly concentrated Am(VII) solutions to be conserved for several minutes. The following scheme is proposed

for the reaction in weakly acid or neutral media: $2AmO_2^{+} + 3H_2O \rightleftharpoons AmO_2^{+} + H_3AmO_5 + 3H^{+}$; while in alkaline solutions the following reaction takes place: $2[AmO_2(OH)_m]^{(m-2)-} + (6 + n - 2m)OH \rightleftharpoons [AmO_2(OH)_n]^{(n-1)-} + AmO_4^{3-} + 3H_2O$. A similar disproportionation reaction may occur also in solutions of $N_p(VI)$. (TTT)

20761 DEUTERIUM AND HYDROGEN SULFIDES: VAPOR PRESSURES, MOLAR VOLUMES, AND THERMODYNAMIC PROPERTIES. Clarke, E. C. W.; Glew, D. N. (Dow Chemical of Canada Ltd., Sarnia, Ont.). Can. J. Chem.; 48: 764-75(1 Mar 1970).

An apparatus is described in which deuterium and hydrogen sulfides were prepared by the hydrolysis of aluminum sulfide. Liquid densities were determined at −79°C and give the molar volumes 34.811 ± 0.003 cm^3 for deuterium sulfide and 34.711 ± 0.003 for hydrogen sulfide. Vapor pressures of deuterium and hydrogen sulfides were determined at −78°C in a quartz-metal apparatus, and in the range −30 to +30°C in a stainless steel apparatus. Equations are derived for the deuterium and hydrogen sulfide vapor pressures and for their ratio. An isotopic vapor pressure cross-over point is found at −48°C, above which deuterium sulfide is more volatile than hydrogen sulfide. Gas and liquid molar volumes and enthalpy changes are evaluated for liquid vaporization at saturation. The deuterium and hydrogen sulfide vaporization standard thermodynamic function changes and their errors, together with the isotopic differences for these functions and their errors, are tabulated between −80 and +50°C. (auth) (Canada)

20762 COMPLEX CHEMICAL STUDIES OF SOME QUADRIVALENT METAL IONS OF FLUORIDE AND SULFATE COMPLEXES. Noren, Bertil. Lund, Sweden; Lund Univ. (1969). 16p. (In Swedish).

Thesis.

The complex systems of the quadrivalent metal ions of zirconium fluoride, zirconium sulfate, hafnium fluoride, thorium fluoride, and uranium fluoride were investigated. The ion exchange method was used for zirconium(IV) fluoride systems, zirconium (IV) sulfate systems, and hafnium(IV) fluoride systems. The extraction method was used for hafnium(IV) fluoride systems, zirconium(IV) fluoride and zirconium(IV) sulfate systems. The ferric method was used for zirconium(IV) and hafnium(IV) fluoride systems. The electrode membrane method was used for thorium(IV) and uranium(IV) fluoride systems. The complex constants for zirconium(IV) and hafnium(IV) were consistently greater than those for the actinides with the exception of uranium. This is expected, if the binding between metal and fluoride ions is basically electrostatic. (Sweden)

20763 HELIUM ISOTOPE EFFECT IN SOLUTION IN WATER AND SEAWATER. Weiss, R. F. (Univ. of California, San Diego, La Jolla). Science; 168: 247-8(10 Apr 1970).

The isotope effect in the solution of helium in water from 0° to 40°C has been determined by microgasometric measurements of the solubilities of pure helium-3 and helium-4. At 0°C helium-3 was less soluble than helium-4 in both distilled water and seawater by 1.2 percent. The observed fractionation factor was 0.988 ± 0.002 at 0°C and appeared to decrease with increasing temperature at the rate of 0.0001 per degree Centigrade, although the existence of this trend was of limited statistical certainty. The measured isotope effect was in agreement with the ratio of helium-3 to helium-4 in surface ocean water reported by Clark, Beg, and Craig (Earth Planet. Sci. Lett. 6,213 (1969)). (auth)

20764 VAPOR-PRESSURE ISOTOPE EFFECT OF ICE AND ITS ISOMERS. Wolff, H. (Univ., Heidelberg). pp 305-19 of Physics of Ice. /Riehl, Nikolaus (ed.). New York; Plenum Press (1969).

From International Symposium on Physics of Ice, Munich, Germany. See CONF-680963.

The vapor pressure isotope effect of compounds forming hydrogen bonds can be explained by the superposition of a normal effect of the intermolecular vibrations and of an inverse effect of the intramolecular vibrations. Its calculation for ice faces the difficulty that the vibrations interact with each other. As far as the valency vibrations are concerned, this difficulty is eliminated by calculating with the uncoupled vibrations. By reasonable choice of the intermolecular vibrations, it is then possible to calculate the vapor pressure isotope effect of H_2O- and D_2O-ice as well as the effect of H_2O- and HDO-ice. The possibility of obtaining the temperature dependence of the vapor pressure isotope effect of the liquid isomers in the same way confirms the explanation given for the solid compounds. Because it is sensitive to deviations of the wave numbers the calculation can serve to ensure the assignment. (auth)

20765 CONTRIBUTION TO THE ELECTROCHEMISTRY OF URANIUM(V) IN CARBONATE SOLUTIONS. Caja, J.; Pravdic, V. (Ruder Boskovic Inst., Zagreb). Croat. Chem. Acta; 41: 213-22 (1969).

Oxidation−reduction reactions of uranium(V) and (VI) in sodium and cesium carbonate solutions at high pH were studied using the chronopotentiometric technique. Uranium(V) formed by electrolysis of uranium(VI) at constant potential is stable, its rate of disproportionation, negligible. The apparent standard redox potential (uncorrected) of the U(VI)/U(V) couple was found to be −0.760V vs. S.C.E. in 1 M Na_2CO_3 and pH = 11.5. The uncorrected overall transfer coefficients for the oxidation of U(V) and re-reduction of U(VI) were: 0.64 and 0.42 in 1 M Na_2CO_3, and 0.47 and 0.47 in 0.5 M Cs_2CO_3. The formal rate coefficients for the oxidation and re-reduction of 1 mmole bulk U(V), referred to the N.H.E. were: 2.1×10^{-9} and 2.7×10^{-8} cm/sec in 1 M Na_2CO_3, and 8.0×10^{-9} and 1.1×10^{-8} cm/sec in 0.5 M Cs_2CO_3. Narrow concentration limits for the solubility of uranium complexes and the relatively low concentration sensitivity of the chronopotentiometric technique render precise quantitative calculations and corrections for double layer effects or counter-ion association rather difficult. (auth)

20766 HYDROGEN BONDING AND VAPOR PRESSURE ISOTOPE EFFECT OF DIMETHYLAMINE. Wolff, H.; Wuertz, R. (Univ., Heidelberg). J. Phys. Chem.; 74: 1600-6(2 Apr 1970).

The vapor pressure isotope effect of two isotopic compounds in solution is given by the ratio p/p′ of their partial pressures in the same solvent, where p and p′ are the partial pressures of the heavy and of the light compound, respectively. The temperature and concentration dependence of this ratio was determined for solutions in n-hexane of $(CH_3)_2NH$, $(CH_3)_2ND$, $(CD_3)_2NH$, and $(CD_3)_2ND$ between +20 and −50°C. The ratio decreases with increasing temperature and is independent of concentration for pairs with equal amino groups but different methyl groups. These observations and the values indicate that the ratio is not influenced by association and depends primarily on the difference of the methyl group vibrations. However, for pairs with equal methyl groups but different amino groups the ratio increases with increasing temperature as well as with dilution, which shows that the ratio depends on association and is determined by the intermolecular vibrations and the internal amino group vibrations. When methyl and amino groups both differ, the ratio is determined by the external and internal amino group vibrations as well as the internal methyl group vibrations. The values of the ratios and their temperature dependence differ from the results for methylamine, because in dimethylamine the number of methyl groups is increased and the association is decreased. Taking into account the association equilibrium, the ratio of partial pressures is given by a two-state function. From this function it has been calculated that the undiluted dimethylamine contains approximately 60 to 40% of free NH or ND groups in the temperature range of +20 to −20°C. Similar results were obtained from infrared measurements in the first harmonics. (auth)

20767 THERMODYNAMIC FUNCTIONS FOR Pu^{3+}(aq) AND THE ENTROPIES FOR SOME TRIVALENT ACTINIDE IONS. Hinchey, R. J.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Inorg. Chem.; 9: 922-6(Apr 1970).

The heat of solution of pure α-phase plutonium metal has been measured in 6.03 and 2.0 M HCl, giving values of −139.4 ± 0.8 and −139.2 ± 0.8 kcal $mole^{-1}$, respectively. The heat of solution of $PuCl_3 \cdot 6H_2O$(c) has been measured as −8.260 ± 0.058 kcal $mole^{-1}$. This value, together with measurements of the solubility of $PuCl_3 \cdot 6H_2O$(c) and reasonable estimates of the activity and osmotic coefficients, led to a value of −44.6 gibbs $mole^{-1}$ for the entropy of Pu^{3+}(aq). A consistent set of entropies has been generated for some other actinide(III) ions. (auth)

20768 THERMODYNAMIC FUNCTIONS OF NEPTUNIUM(V) AND NEPTUNIUM(VI). Brand, J. R.; Cobble, J. W. (Purdue Univ., Lafayette, Ind.). Inorg. Chem.; 9: 912-17(Apr 1970).

The solubility and heat of solution of $NpO_2(NO_3)_2 \cdot 6H_2O$ have been measured, giving values for the free energy and heat of solution of −2940 cal $mole^{-1}$ and 5060 cal $mole^{-1}$, respectively. Estimation of the entropy of $NpO_2(NO_3)_2 \cdot 6H_2O$ as 123.4 gibbs $mole^{-1}$ then fixes the entropy of NpO_2^{2+}(aq) as −20 ± 2 gibbs $mole^{-1}$. The heat of reduction of NpO_2^{2+}(aq) to NpO_2^{+}(aq) by hydrogen peroxide was found to be −10,310 cal $mole^{-1}$ and E^0 for the $NpO_2^{2+}-NpO_2^{+}$ couple was measured as −1.236 V. These data permit calculation of the entropy of NpO_2^{+}(aq) as −6.2 ± 2 gibbs $mole^{-1}$. By comparison of the E^0 for the $NpO_2^{2+}-NpO_2^{+}$ electrode and the formal potential reported elsewhere, corrections could be estimated for adjusting the $UO_2^{2+}-UO_2^{+}$, $PuO_2^{2+}-PuO_2^{+}$, and $AmO_2^{2+}-AmO_2^{+}$ formal potentials to true E^0 values. These were found to be −0.163, −1.013, and −1.70 V, respectively. (auth)

20769 PLUTONIUM SPECIES IN PROPANE-1,2-DIOL CARBONATE SOLUTION. PREPARATION OF A MULTIVALENT PLUTONIUM COMPOUND. Cleveland, J. M.; Bryan, G. H.;

Eggerman, W. G. (Dow Chemical Co., Golden, Colo.). Inorg. Chem.; 9: 964-6(Apr 1970).

Studies were made on the chemistry of the plutonium–chloride system in nonaqueous propane-1,2-diol carbonate (PDC) solution. The results showed that solutions of Pu in reasonable concentrations in propane-1,2-diol carbonate may be prepared by dissolution of the metal in chlorine-saturated solvent. The resulting solution contains Pu(III), $PuCl_6^{3-}$, and possibly a minor concentration of lower anionic complexes of Pu(IV) as the only ionic species. Addition of benzene to the solution causes precipitation of a compound containing only these ions, namely, $[Pu(III)(PDC)_7]_2(Pu(IV)Cl_6)_3$. (P.C.H.)

20770 MECHANISM OF THE CATALYTIC ISOMERIZATION OF CYCLOPROPANE OVER BROENSTED ACID CATALYSTS. George, Z. M.; Habgood, H. W. (Research Council of Alberta, Edmonton). J. Phys. Chem.; 74: 1502-8(2 Apr 1970).

The isomerization of cyclopropane over a Brønsted acid catalyst takes place via a protonated cyclopropane intermediate, which on ring opening gives propylene probably through a primary propyl cation. With a deuterated catalyst the propylene product is randomly deuterated and, for a fully deuterated catalyst, the extent of monodeuteration during isomerization is 85%, which is close to 6/7 as expected for complete mixing with no isotope effect of one D and 6 H's. These results suggest that the $c\text{-}C_3H_6D^+$ ion probably has sufficient time to equilibrate among its various isotopic forms before the ring opens. A lower degree of deuteration during the isomerization step may be found if the catalyst is incompletely deuterated, and this was found to be the case for NaY catalyst equilibrated with D_2O at 300°C. Some catalytically active sites that do not readily exchange with D_2O form a significant fraction of the acid sites on a catalyst of low acidity such as NaY. These peculiar sites are of negligible importance in practical catalysts such as NaHY zeolite, which have much higher total acidity. (auth)

20771 REACTIONS OF EIGHT-COORDINATE METAL CYANIDE COMPLEXES. II. INTERACTION OF OCTACYANOMOLYBDATE(IV) WITH URANYL SALTS. Allen, Mark; Lippard, Stephen J. (Columbia Univ., New York). Inorg. Chem.; 9: 991-3 (Apr 1970).

Studies were made on the reaction between uranyl salts, such as uranyl nitrate, uranyl chloride, or uranyl acetate, and octacyanomolybdate(IV) in order to determine the structure and to provide further information about the uranyl-octacyanomolybdate (IV) reaction. It was concluded that the red-brown color that appears when $[Mo(CN)_8]^{4-}$ and UO_2^{2+} ions are allowed to react in aqueous solution does not correspond to an increase in the coordination number of the molybdenum atom. Instead, it was found that the nitrogen atoms of the cyanide ligands are bonded to the uranyl groups to form a complex that is probably polymeric. (P.C.H.)

20772 VAPOUR PRESSURE OF $H_2{}^{18}O$ ICE (I) (-17°C TO 0°C) AND $H_2{}^{18}O$ WATER (0°C TO 16°C). Jansen, G.; Pupezin, J.; Van Hook, W. A. (Univ. of Tennessee, Knoxville). Nature (London); 225: 723(21 Feb 1970).

The vapor pressure isotope effect (VPIE) between $H_2{}^{18}O$ and $H_2{}^{16}O$ ice was determined from –17 to 0°C; the results obtained were in disagreement with those reported by Matsuo and Matsubaya (Nature 221: 463(1969)). The VPIE in the liquid phase was also determined, with results in good agreement with Szapiro and Steckel (Trans. Faraday Soc. 63: 883(1967)). From the data an ice-liquid fractionation factor of 1.0030 ± 0.002 was calculated. A brief description of the apparatus employed is given. The $H_2{}^{18}O$ had a mass spectrometric analysis of ^{18}O 69.0 ± 0.5%, ^{17}O = 1.4 ± 0.2%, with a deuterium concentration only 1.03 ± 0.01 times normal abundance. It was concluded that the results of Matsuo and Matsubaya are about 20% low, probably due to experimental difficulties arising from their extremely small samples. (UK)

20773 THE QUENCHING OF MERCURY ($^3P_1$) RESONANCE RADIATION BY AROMATIC MOLECULES. Mains, Gilbert J.; Trachtman, Mendel (Philadelphia Coll. of Textiles and Science). J. Phys. Chem.; 74: 1647-9(2 Apr 1970).

Quenching of the $^3P_1$ excited electronic state of atomic mercury by benzene, benzene–d_6, and eight substituted benzene compounds was studied. The quenching cross sections were calculated. A very large isotope effect was observed. (M.C.G.)

20774 ASSIGNMENTS OF CONFIGURATION BY NUCLEAR OVERHAUSER EFFECTS IN SOME DIBENZTHIEPIN DERIVATIVES. Fraser, R. R.; Schuber, F. J. (Univ. of Ottawa). Can. J. Chem.; 48: 633-40(15 Feb 1970).

The configuration of the benzylic protons responsible for each absorption in the nuclear magnetic resonance spectra of 1,11-dimethyl-5, 7-dihydrodibenz(c,e)thiepin and its S-oxide and S-dioxide was determined by nuclear Overhauser experiments. Successful application of the method was achieved by using partially deuterated derivatives for the purpose of removing undesirable relaxation mechanisms between protons. Triple irradiation of doublets was also usefully employed. The sulfoxide assignments arrived at herein reverse the tentative assignments put forth by us. It is noteworthy that all experiments on the sulfoxide failed when $CDCl_3$ was used as solvent. In DMSO normal nuclear Overhauser effects were seen, presumably since sulfoxide dimers are not formed in this solvent. The sulfonium perchlorate derivative of the thiepin was also synthesized. The remarkable similarity of its NMR spectrum to that of the sulfoxide is interpreted as evidence that the effect of the sulfoxide group on the shifts of neighboring protons is due primarily to the "lone pair" on sulfur. (auth) (Canada)

20775 ELECTRIC POLARISATIONS OF SOME METAL ACETYLACETONATES AT 29.7 cm^{-1}. Haigh, J.; Sutton, L. E. (Physical Chemistry Lab., Oxford). J. Chem. Soc., D; No. 5, 296-7(4 Mar 1970).

Electric polarizations at 29.7 cm^{-1} of the acetylacetonates of Fe(III), Cr(III), Mn(III), Co(III), Al(III), and Th(IV) confirmed that there is a large dispersion at lower frequencies which seems, however, not to be due to a simple, single Debye-type relaxation process. (auth) (UK)

20776 SELF-DIFFUSION COEFFICIENTS OF ^{106}Ru AND $^{106}RuNO$ IN IONIC AND COLLOIDAL STATES. Kepak, F.; Kriva, J. (Nuclear Research Inst., Rez, Czech.). J. Inorg. Nucl. Chem.; 32: 719-29(Mar 1970).

The self-diffusion coefficients were determined by the capillary method as a function of pH and ionic strength of solution. From the values of D and from viscosity data the radii of the respective ions or colloidal particles were calculated. The values of D were found to be in the range 10^{-7} to 10^{-5} cm^2/sec; the radii of the colloidal particles of ruthenium (IV) hydroxide and nitrosylruthenium(III) hydroxide attained 34 Å. (auth) (UK)

20777 ACETYLACETONE AND β-KETOIMINE SOLVATES OF DIOXOBIS-(ACETYLACETONATO)URANIUM(VI). Haigh, J. M.; Thornton, D. A. (Univ. of Cape Town). Inorg. Nucl. Chem. Lett.; 6: 231-5(Feb 1970).

It is stated that whilst many solvates of uranyl acetylacetonate have been described, considerable confusion exists with regard to the composition and structures of some of these compounds. Thus the acetylacetone adduct of uranyl acetylacetonate, usually formulated $UO_2(AA)_2$, HAA (HAA = acetylacetone), has been reported to exist in an alternative form designated H $[UO_2(AA)_3]$ in which three bidentate acetylacetonate ligands are presumed to be in an equivalent environment. Also, whilst the ir spectrum and heat of solvation of an ammonia adduct formulated $UO_2(AA)_2 \cdot NH_3$ have been reported, the method of synthesis was shown to yield a product containing a third molecule of acetylacetone. The results are reported of an application of ir and PMR methods in an attempt to resolve these anomalies. The ir spectra of anhydrous $UO_2(AA)_2$ and its acetylacetone adduct show that the C–O and C–C stretching frequencies of the former are doubled in the spectrum of the adduct, indicating a third, uniquely bonded molecule of acetylacetone. The PMR spectra also lead to a similar conclusion. The PMR spectrum for the "ammonia" compound was consistent with the formation of a β-ketoimine adduct of uranyl acetylacetonate, and all attempts to prepare $UO_2(AA)_2NH_3$ failed. Repetition of the reaction with a large series of primary and secondary amines capable of β-ketoimine formation always yielded analogous products. (UK)

20778 INCORPORATION OF THE LANTHANIDES AND ACTINIDES INTO THE PERIODIC SYSTEM. Hardt, Horst-Dietrich (Univ., Saarbruecken, Ger.). Naturwiss. Rundsch.; 22: 302-4(Jul 1969). (In German).

A revised periodic table, including the lanthanides in 3 columns so that f^0, f^7, and f^{14} elements fall under each other, with Eu and Yb displaced to the left between the alkaline earths and Gd and Lu, respectively, is suggested. Such a rearrangement coordinates data for melting points, atomic volumes, electron configuration, metallic structure, and colors of the M(III) ions in a periodic fashion. The arrangement also accounts for the position of Y(III) in the basicity series for the lanthanides. The lanthanides thus become a transition within a transition series, but with vertical divisions. A similar decomposition of the actinide series is proposed, with Cm below Ac, and Lw below Cm; again, Am and No are displaced to the left, between the alkaline earths and Ac. (BBB)

20779 PREPARATION OF URANIUM SULFIDE FROM URANIUM TETRAFLUORIDE. Mitamura, Takashi (Saitama Univ., Urawa, Japan); Kanno, Masayoshi; Mukaibo, Takashi. Denki Kagaku; 38: 27-32(Jan 1970). (In Japanese).

Preparation of US by the reaction of UF_4 with Al and S was investigated under Ar at temperatures between 900 and 1100°C. In the sulfidization of UF_4, the most favorable molar ratio (Al/UF_4) was 2. The x-ray pattern of the products obtained from a powder of UF_4, Al, and S in a molar ratio of 1:2:5, at the above-mentioned temperatures showed UF_3 and US. The intensity ratio of US to UF_3 increased with time. However, the x-ray pattern of the product obtained by reaction for 2 hrs at 1100°C showed that the diffraction line of US disappeared simultaneously with the disappearance of that of UF_3. The products obtained from a powder mixture of UF_4, Al, and S in a molar ratio of 1:2:7 or more, at 900°C for 60 min were U_2S_5 and US. On the other hand, treatment of the product obtained from a powder mixture of UF_4, Al, and S at a molar ratio of 1:2:5, at above 900°C for 60 min with S vapor, formed a single phase of β-US_2 in a relatively short period of time. (auth) (NSA of Japan)

20780 CHEMICAL PROPERTIES OF TECHNETIUM IN SOLUTION. Ossicini, Luigia; Skukla, Shyama Kant (Univ., Rome. CNR, Rome). pp 103-12 of Metodologie Analitiche ed Equilibri in Soluzione. Roma; Consiglio Nazionale delle Ricerche (1968). (In Italian).

From Conference on Analytic Methodology and Equilibrium in Solution, Rome, Italy. See CONF-670126.

A detailed study was made on the behavior of TcO_4^- in various solutions. The behavior during the reduction of the ion in HCl, HBr, HNO_3, H_2SO_4, and HF was studied as a function of the concentration of the acid, temperature, and aging time of the solution. The stability of compounds of Tc in the VII, V, and IV oxidation states were measured. The hydrolysis of $TcCl_6^{2-}$ in dilute HCl and of $TcBr_6^{2-}$ and TcF_6^{2-} in dilute HBr and HF solutions and in neutral and basic solutions was also studied. The results obtained are given in graphic form. (J.S.R.)

20781 ANALYTICAL STUDIES OF NITROGEN AND HYDROGEN LIGANDS. Maggio, Francesco (Univ., Palermo, Italy). pp 118-20 of Metodologie Analitiche ed Equilibri in Soluzione. Roma; Consiglio Nazionale delle Ricerche (1968). (In Italian).

From Conference on Analytic Methodology and Equilibrium in Solution, Rome, Italy. See CONF-670126.

The nature and stability of nitrogen complexes with transition metals is considered on the basis of previous studies. The complexes of transition metals with benzohydroxamic acids and the use of these acids as standards in acidimetry are also discussed. (J.S.R.)

20782 THERMAL DECOMPOSITION OF URANYL DIHYDROGEN ORTHOPHOSPHATE TRIHYDRATE. Kamo, Mutsukazu; Ohashi, Shigeru (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Jap.; 43: 84-9(Jan 1970).

The thermal decomposition of uranyl dihydrogen orthophosphate trihydrate was studied by means of paper chromatography, x-ray diffractometry, differential thermal analysis, thermogravimetric analysis, infrared spectroscopy, and chemical analysis. From these studies, it was revealed that in the thermal decomposition of the uranyl salt the following reactions take place. 1) The formation of condensed phosphates with relatively small polymerization degrees such as di- and triphosphates takes place below 300°C, accompanied by the elimination of water. 2) A uranyl salt of long-chain metaphosphate, $[UO_2(PO_3)_2]_n$ is produced between 300 and 840°C. 3) The metaphosphate is melted at about 900°C, while uranium(VI) is reduced to uranium(IV) at the same time. 4) As a result of the reduction, the formation of uranium(IV) diphosphate, UP_2O_7, starts. 5) Finally, almost pure uranium(IV) diphosphate is produced at 1200°C. (auth)

20783 THE CHEMISTRY OF AMERICIUM. I. A STUDY OF THE PREPARATION OF Am(V) AND ITS BEHAVIOR BY MEANS OF TTA EXTRACTION. Hara, Mitsuo (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 89-94(Jan 1970).

The method for preparing Am(V) in various solutions was investigated by utilizing the difference in extractability between Am(V) and Am(III) in a TTA–isobutanol extraction system; Am(III) was quantitatively extracted with 0.1M TTA in isobutanol from a 1M acetate buffer solution at a pH > 3, while the percentage of Am(V) extracted into the organic phase was increased substantially with an increase in the pH from 3 to 5. When the organic phase containing Am(V) was shaken with an aqueous phase having a proper pH value and composition, Am(V) was selectively stripped into the aqueous phase. The stability of the valency state of Am(V) in perchlorate, acetate, and sulfate solutions was then studied by examining the variation in the percentage of Am extracted as a function of the standing time. The rate of change in the valency state in the acetate and the perchlorate media is very slow, while it is rather rapid in the sulfate medium. This difference may be attributable to the faster rate of the disproportionation reaction of Am(V) in the last medium than in the former two. By applying the above results, the chemical behavior of Am(V) in the aqueous solution was investigated by TTA extraction; it was found that Am(V) would be in the form of AmO_2^+ in the absence of a complexing reagent. By the addition of acetate ions, the step-by-step formation of the acetate complex of Am(V) was observed. The stability constants of $[AmO_2Ac]$ and $[AmO_2Ac_2]^-$ were determined to be (25.0 ± 3.1) $(mol/l)^{-1}$ and (12.8 ± 1.2) $(mol/l)^{-2}$ respectively. (auth)

20784 HYDROLYSIS OF THE BERYLLIUM ION IN HEAVY WATER. Kakihana, Hidetake; Maeda, Masunobu (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 43: 109-13(Jan 1970).

The hydrolysis of Be^{2+} ions in heavy water containing 3M $NaClO_4$ as an ionic medium was investigated at 25°C by potentiometric titrations, employing a technique of constant-current coulometry. The deuterium ion concentrations were measured by the use of a commercial glass electrode. The emf data in the range of the total beryllium concentration from 2.5 to 10 mM can be explained on the basis of the following complex formation: $Be_3(OD)^{3+}$, $-\log\beta_{1,3} = 3.28 \pm 0.04$; $Be_3(OD)_3^{3+}$, $-\log\beta_{3,3} = 9.399 \pm 0.007$; $Be(OD)_2$, $-\log\beta_{2,1} = 11.89 \pm 0.07$. The composition of the species formed in heavy water is the same as that in light water, but the values of the stability constants are smaller in heavy water than in light water. (auth)

20785 AROMATIC SULFONYLATION. I. KINETICS AND KINETIC ISOTOPE EFFECTS IN THE SULFONYLATION. Kobayashi, Michio; Minato, Hiroshi; Kohara, Yoshio (Tokyo Metropolitan Univ.). Bull. Chem. Soc. Jap.; 43: 234-9(Jan 1970).

p-Toluenesulfonylation of toluene, chlorobenzene, and bromobenzene in the presence of aluminum chloride was investigated in methylene chloride at 0 to 20°C. The rate was equal to $k_3[TsCl][AlCl_3][ArH]$. Kinetic hydrogen isotope effects were found for p-deuteriotoluene ($k_H/k_D = 2.8$) and p-deuteriochlorobenzene ($k_H/k_D = 1.98$). Infrared studies indicated that not a sulfonyl cation but $TsCl-AlCl_3$ complex was present in the medium. Substitution took place exclusively at para positions for halobenzenes, but 13.4% ortho and 86.6% para isomers were obtained for toluene. Partial rate factors for para positions were 52.5 ($PhCH_3$), 0.224 (PhCl) and (0.164(PhBr). A plausible reaction mechanism was proposed, in which the abstraction of proton from the σ-complex was rate-determining. (auth)

20786 THE CRYSTAL STRUCTURE OF $(NH_4)_4UF_8$. Rosenzweig, Abraham; Cromer, Don T. (Los Alamos Scientific Lab., N. Mex.). Acta Crystallogr., Sect. B; 26: 38-44(1970).

The crystal structure of $(NH_4)_4UF_8$ has been determined from counter measurements of 849 reflections and refined by full-matrix least squares with anisotropic thermal parameters to an R index of 0.048. The space group is C2/c with four formula units in a unit cell with $a = 13.126 \pm 0.005$, $b = 6.692 \pm 0.003$, $c = 13.717 \pm 0.005$ Å and $\beta = 121°19'$. The calculated density is 2.982 $g.cm^{-3}$ and the measured density is 2.96 $g.cm^{-3}$. The uranium atom has 8 fluorine neighbors at an average distance of 2.28 Å which form a distorted tetragonal antiprism. These discrete polyhedra are linked via the ammonium ions, presumably through N–H --- F hydrogen bonds. The four fluorine atoms nearest each nitrogen atom are roughly tetrahedrally disposed. The structure is compatible with the observed morphology and cleavage. The crystals usually twin on (001). There are several possible twinning mechanisms which result in a minimum distortion of the packing at the twin boundary. This compound is isostructural with analogous Pa, Am, Np and Pu compounds. (auth)

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Refer also to abstracts 20727, 20842, 21543, 21873, 22145, and 22150.

20787 (AECL-3524) PULSE RADIOLYSIS. A Comprehensive Bibliography, 1960–March 1969. Greenshields, H.; Seddon, W. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan 1970. 66p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

A search of abstract and indexing sources for the period 1960 to March 1969 provided most of the material that appears in this bibliography. The sources searched were, Nuclear Science Abstracts, Chemical Abstracts, and Science Citation Index (S.C.I.). The remainder of the references was supplied by research associates in response to correspondence. The references are listed in broad subject groups and are sub-arranged by year, latest publication first. The entries are alphabetically ordered by authors' surname, then by title. Each entry is numbered serially, including the Appendix entries, which are arranged in the same subject groups as the main bibliography. The number of the first and last

entry on each page is identified to facilitate entry location. An alphabetical author index is supplied for quick reference. Abbreviated titles, sub-arranged alphabetically, are incorporated where two or more articles by the same author have been included in the bibliography. All co-authors are referenced so that the total authorship of each included paper can be established. (auth)

20788 (CEA-CONF-1417) RADIORETICULATION OF NATURAL AND SYNTHETIC ELASTOMERS IN EMULSIONS OR DISPERSIONS. Laizier, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Noel, M. T.; Pordes, M.; Veber, A. (Societe Mapa-Fit, Les Lilas (France)). [1967]. 14p. (In French). (SM-123/13; CONF-690805-13). Dep. CFSTI (U. S. Sales Only).

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

By irradiating elastomers with electrons or γ rays at a dose of 1 Mrad, it is possible to produce industrially some rubber compounds possessing the properties of traditional chemical vulcanites. For natural materials, the radiation dose is lowered by the addition of small percentages of chlorine compounds. Among the compounds, CCl_4 proved to be the most effective. Certain polymerizable vinyl or acrylic monomers also permit the dose to be lowered. The additives are added in the form of fine and stable emulsions. The elasticity is obtained by the addition, before or after irradiation, of low doses of elementary sulfur in stable dispersion (0.2%). The paraffinic oils permit films possessing the maximum elastic quality to be obtained. Certain synthetic latexes, such as polychloroprene latex, do not need any additive or lower radiation dose. (tr-auth)

20789 (JINR-E6-4916) THERMAL ANNEALING BEHAVIOUR OF RADIORHENIUM RECOILS FORMED BY HIGH ENERGY PROTON IRRADIATION OF SODIUM HEXACHLOROIRIDATE. Ianovici, E.; Zaitseva, N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 16p. Dep. CFSTI (U. S. Sales Only).

The thermal annealing behavior of radiorhenium recoils formed by irradiation of anhydrous sodium hexachloroiridate with 660-MeV protons was studied. The influence of irradiation-induced defects and inherent crystal defects on the subsequent thermal annealing of radiorhenium recoils is described. The activation energy of the annealing process is calculated. (auth)

20790 (NP-18170) THE EFFECT OF γ-RADIATION IN COLLAGEN SOLUTIONS. A PHYSICO-CHEMICAL STUDY. Labout, Johannes Jacobus Maria (Utrecht Rijksuniversiteit (Netherlands). Fysisch Laboratorium). 1970. 71p. Dep. CFSTI (U. S. Sales Only).

Thesis.

A study was made on the behavior of collagen solutions under high-energy radiation. Irradiation of proteins gives rise to molecular changes that often cannot be realized in other ways. Such structural changes in the protein molecule, which may be too small to be observed with chemical methods, may cause a drastic biological or physical effect. In dilute aqueous solutions the free water radicals such as the hydrated electron (e_{aq}), the hydroxyl radical (OH') and the hydrogen atom (H'), which are freed after energy absorption by water, are primarily responsible for the chemical changes of the solutes. The protein collagen, which is insoluble in pure water, but soluble in, for instance, citrate buffer or aqueous acetic acid, has a characteristic rod-like structure. Changes in this structure caused by irradiation in solution were evaluated, using physico-chemical methods such as light scattering, viscometry, and electron microscopy. Special attention was paid to the preparation of monodisperse solutions of native collagen, as required for the light-scattering measurements. Solutions of collagen in citrate buffer or aqueous acetic acid (pH < 4) were irradiated with ^{60}Co γ rays. Collagen concentrations of 0.055 to 0.5% were used. In the absence of oxygen irradiation caused "crosslinking" of the protein molecules, finally resulting in the formation of a gel. The crosslinks are likely to be covalent bonds. Via the action of free water radicals macroradicals are formed. The crosslinking reaction proceeds either between two macroradicals or between a macroradical and another intact macromolecule. No more than four water radicals are needed to form a crosslink between two collagen molecules. Various other free radical scavengers, which also may affect the gelation dose were added to detect the kind of water radical responsible for the cross linking. An analysis of the experimental results indicated that the hydrogen atom starts in the crosslinking process. The ratio of the rate constant K(H + collagen)/K (H + acetic acid) was found to be 2.4×10^4. If the value 4×10^5 $\underline{M}^{-1}$ sec^{-1} is taken for the rate constant of the reaction between acetic acid and H', the rate constant for the reaction between collagen and H', followed by a crosslinking reaction, is estimated to be about 10^{10} $\underline{M}^{-1}$ sec^{-1}. A possible explanation for the fact that H' causes crosslinking and OH' does not is that the hydrogen atoms reduce some special sites on the collagen molecule to groups bearing an aldehyde function. The macroradicals once formed react further in a crosslinking reaction in such a way that the molecular weight and the viscosity increase continuously until gelation occurs. In particular the hydrodynamic behavior of the solutions points to branching. The radioinduced crosslinking process was considered to proceed similarly to the polycondensation of a polyfunctional monomer. From the change of the molecular weight with irradiation time, obtained from lightscattering data, it was estimated that many reactive sites (certainly more than five, maybe many more) on a collagen molecule are able to crosslink. This helps to understand the fact that the crosslinking is a very efficient process, i.e., that no more than two water radicals, i.e., hydrogen atoms, are required for the activation of one reactive crosslinking site. (auth)

20791 (NYO-4106-1) CHEMICAL STUDY OF THE EFFECTS OF RADIATION ON NUCLEIC ACIDS AND RELATED COMPOUNDS. Annual Progress Report, June 15, 1969-June 14, 1970. Wang, Shih Yi (Johns Hopkins Univ., Baltimore, Md. Dept. of Biochemistry). Contract AT(30-1)-4106. 5p. Dep. CFSTI.

Studies were made on the x radiolysis of purine and pyrimidine bases such as guanine, adenine, thymine, uracil, and cytosine. Following x irradiation and subsequent dilution the uv absorbency of the samples was measured. The samples showed decreased absorbency as compared with that of the corresponding unirradiated material. Since there were no detectable amounts of uv absorbing products formed, it was assumed that loss of absorbency at around λ_{max} is a measure of the radiation damage to the chromophore in the compounds studied. Plots were constructed using the decrease in optical density at λ_{max} versus delivered dose. The results indicated increased chromophoric loss with increased solute concentration. Preliminary results obtained with DNA x irradiated in vitro and in vivo confirmed previous observations that cyclobutyl dimerization is absent in x-irradiated DNA. (P.C.H.)

20792 (ORNL-4447) TRANSURANIUM PROCESSING PLANT SEMIANNUAL REPORT OF PRODUCTION, STATUS, AND PLANS FOR PERIOD ENDING JUNE 30, 1969. Burch, W. D.; Bigelow, J. E.; King, L. J. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 34p. Dep. CFSTI.

The status and the future production plans of the Transuranium Element Production Program at ORNL are reported. The total amounts of transuranium elements processed during the period January 1 to June 30, 1969, are (approximately): 0.3 g of ^{243}Am, 17 g of ^{244}Cm, 9.2 mg of ^{252}Cf, 1.2 mg of ^{249}Bk, 86 μg of ^{253}Es, and 10^8 atoms of ^{257}Fm. The sequence of process steps currently being used at TRU is presented, and the status of each step is summarized. The steps are as follows: (1) a feed solution is prepared by dissolving irradiated targets; (2) the plutonium is recovered using a batch solvent extraction process (Pubex); (3) the transplutonium elements are decontaminated from fission products by countercurrent solvent extraction (Tramex); (4) the americium and curium are separated from the transcurium elements by ion exchange or solvent extraction; (5) the transcurium elements are separated from each other by chromatographic elution with α-hydroxyisobutyrate from a high-pressure ion exchange column; (6) the plutonium, americium, and curium are made into oxides (in the form of microspheres), using a sol-gel technique; and (7) the microspheres are fabricated into HFIR targets, by remote means, for reirradiation to produce more transcurium elements. Services are also available at TRU by which special materials not normally produced in main-line efforts can be prepared. Four rabbits containing ^{253}Es were prepared and irradiated in the HFIR to produce 39.3-hr ^{254m}Es for use at ANL in studying the energy level structure of the decay product, ^{250}Bk. A neutron source, containing 100 μg of ^{252}Cf, was fabricated for the Oak Ridge Associated Universities. This source will be used in their training program. The values used for transuranium element decay data and for cross-section data in planning irradiation-processing cycles, calculating production forecasts, and assaying products are tabulated in the Appendix. (auth)

20793 (ORNL-tr-2006) PRODUCTION OF RADIOISOTOPES IN A SYNCHROCYCLOTRON. Palcos, M. C.; Radicella, R.; Rodriguez, J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Translated by J. J. Pinajian and Martha Gerrard (Oak Ridge National Lab., Tenn.), from report NP-12231. 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 17: 10676.

20794 INVESTIGATIONS ON THE SZILARD-CHALMERS EFFECT IN PHENYL-ARSENIC COMPOUNDS. INFLUENCE OF

IRRADIATION CONDITIONS. PART 3. TRIPHENYLARSENIC COMPOUNDS. Grossmann, G. (Technische Univ., Dresden). Radiochim. Acta; 13: 31-7(Feb 1970). (In German).

The compounds $Ph_3As(OH)_2$, Ph_3AsO, and Ph_2As were irradiated at different neutron fluxes, intensities of γ radiation, and temperatures in vacuum or in the presence of air. A thermal treatment (annealing) occurs in many cases. The distribution of radioactive arsenic atoms on products with different numbers of phenyl groups per arsenic atom is determined. The following problems are discussed: activity distribution resulting from primary and secondary effects; change of the diffusion-controlled secondary effects by oxygen as a radical scavenger; tertiary processes run off by the thermal annealing; quaternary effects resulting from γ radiation. For $Ph_3As(OH)_2$, Ph_3AsO and Ph_3As the sum of primary and secondary retention (yield of Ph_2As products) is 2, 1.5, and 2.5%, the yield of Ph_2As products is 2, 3, and 2% and the yield of PhAs products is 13, 16.5, and 16% respectively. (auth)

20795 BEHAVIOR OF TETRAETHYLGERMANIUM DURING ACTIVATION IN A NUCLEAR REACTOR. Nowak, Maciej; Akerman, Karol (Kernforschungsinstitut, Warsaw). Radiochim. Acta; 13: 48-55(Feb 1970). (In German).

Tetraethylgermane was activated in the thermal column of the nuclear reactor EWA. The compounds of radioactive germanium and arsenic formed were separated by extraction, high-tension paper electrophoresis, and radio-gas chromatography. The yields and chemical structure of radioactive products were determined. (auth)

20796 MECHANISM AND KINETICS OF RADIOLYTICALLY INITIATED CYCLOHEXYL RADICAL ADDITION TO cis- AND trans-1,2-DICHLOROETHYLENE AND OF THE SUBSEQUENT CHLORINE ATOM ELIMINATION REACTION. Horowitz, A.; Rajbenbach, L. A. (Soreq Nuclear Research Centre, Yavne, Israel). J. Amer. Chem. Soc.; 92: 1634-7(25 Mar 1970).

The kinetics of γ-induced formation of cis- and trans-1-cyclohexyl-2-chloroethylene by a free-radical chain mechanism in binary solutions of cis- and trans-1,2-dichloroethylene in cyclohexane was studied at 150°C. The condensation reaction between the solvent and the two solutes resulted in the formation of equal ratios of cis- and trans-$c\text{-}C_6H_{11}CH = CClH$. The condensation reaction was found to proceed via addition of cyclohexyl radicals to the olefins followed by subsequent elimination of a chlorine atom from the intermediate radical. The rate constants for the addition of cyclohexyl radicals to cis- and trans-1,2-dichloroethylene are estimated at $3.1 \pm 0.4 \times 10^4$ and $9.7 \pm 0.7 \times 10^4$ M^{-1} sec^{-1}, respectively. The rate constants of the chlorine elimination reaction are estimated at $8.6 \pm 2.6 \times 10^3$ and $1.12 \pm 0.37 \times 10^4$ sec^{-1} for the radicals obtained from solutions of cis and trans isomers, respectively. The possible mechanisms of the addition and elimination reactions are discussed. (auth)

20797 EFFECT OF ACIDS ON THE GAMMA-RADIOLYSIS OF FROZEN AQUEOUS SYSTEMS OF SOME ORGANIC COMPOUNDS. Moorthy, P. N.; Gopinatthan, C.; Rao, K. N. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 2: 175-85(Feb 1970).

ESR spectra of γ-irradiated frozen aqueous solutions of a number of organic compounds such as alcohols, ether, acetone, and tetrahydrofurans were examined in the presence and absence of mineral acids such as H_2SO_4. The presence of the acid is found to cause an intensification of the organic radical ESR spectra as compared with the acid-free solutions. Also, the presence of the organic compounds in frozen aqueous H_2SO_4 suppresses the formation of both H atoms and SO_4^- radical ions. These results were explained on the basis of reactions of the electrons and holes, or excitons, primarily formed by the action of radiation on the substrate ice. (auth)

20798 RADIATION CHEMISTRY OF TRIS(ACETYLACETONATO) COBALT(III) IN AQUEOUS SOLUTIONS. Rama Rao, K. V. S.; Shastri, L. V.; Shankar, J. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 2: 193-200(Feb 1970).

On radiolysis, tris(acetylacetonato)cobalt(III) in aqueous solutions is reduced by reaction with (1) hydrated electrons, (2) H atoms, (3) OH radicals, and (4) C_2H_4OH radicals. The bimolecular rate constants for the first three reactions, determined by competition kinetics are: 4×10^{10}, 2.3×10^9, and 4.7×10^9 $M^{-1}sec^{-1}$ respectively. Absorption spectra of the irradiated solutions indicate the formation of bis(acetylacetonato)cobalt(II) from reaction (1), but not from (3). The total cobaltous yield in air-free solutions is given by $G(Co^{2+}) = 5.6$ and 6.5 at pH 6.5 and 1, respectively. It appears that $G_{e^-_{aq}} \simeq G_H + G_{OH} \simeq 2.8$ in neutral solutions. Considerations of material balance for the primary yields of radiolysis of water suggest the possibility that the so-called independent H atoms in neutral solutions are probably excited water molecules or ion-pairs. (auth)

20799 GAMMA-RADIOLYSIS OF DEAERATED CYSTEINE SOLUTIONS. Lal, M. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 2: 225-6(Feb 1970).

Air-free cysteine solutions were irradiated at high gamma dose rates for short times and analyzed immediately for hydrogen peroxide and cysteine yields. The results, compared with analyses after 24-hr standing of irradiated solutions, indicate that hydrogen peroxide does not react with cysteine at cysteine concentrations of 10^{-2} and 10^{-3} M at pH 0 and 5.4. (D.L.C.)

20800 CHEMICAL BEHAVIOR OF CARRIER FREE IODINE PRODUCED BY BETA-DECAY AND EFFECTS OF IODINE CARRIERS. Hashimoto, Tetsuo; Tamai, Tadaharu; Matsushita, Rokuji; Kiso, Yoshiyuki (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 92-6(Feb 1970).

The effect of carriers on the behavior of ^{131}I produced from the ^{130}Te (n, γ) $^{131}Te \xrightarrow{\beta^-} {}^{131}I$ processes was investigated by paper electrophoresis, autoradiography, and γ spectrometry. If no carrier was added, the chromatograms of the iodine species revealed significant deposits of an unexpected chemical species between the spots of the iodide and iodate species. The addition of either iodate or periodate as carrier converted the species into iodate in the former case, and into iodate and periodate in the latter. Referring to the already known exchange reactions between different iodine species, it was concluded that the species observed in the experiment without carrier was the iodite (IO_2^-), as surmised by previous authors. (auth)

20801 RADIATION CHEMICAL STUDIES WITH CYCLOTRON BEAMS. I. FRICKE SOLUTION. Matsui, Masao; Seki, Hiroshi; Karasawa, Takashi; Imamura, Masashi (Inst. of Physical and Chemical Research, Yamato, Japan). J. Nucl. Sci. Technol. (Tokyo); 7: 97-104(Feb 1970).

Systematic studies on the LET effect in the radiolysis of organic liquids was initiated using various types of heavy ions accelerated by a cyclotron. The effects of differences in irradiation conditions, in particular beam current, stirring speed, and concentration of solutes were examined. Aerated aqueous ferrous sulfate solutions (Fricke solutions) were subjected to irradiation by protons and He ions of various energies, to take advantage of the well-established reaction mechanism of the system. Experimental results obtained under various conditions were analyzed on the basis of the diffusion kinetics model. It was revealed that meticulous care must be taken to control the experimental conditions in studying radiolysis with heavy ions. The oxidation yields of ferrous ions were also determined as a function of linear energy transfer. (auth)

20802 SEPARATION OF CARRIERFREE $^{131}I^-$, $^{131}I^0$, $^{131}IO_3^-$, AND $^{131}IO_4^-$ BY PAPER CHROMATOGRAPHY AND PAPER ELECTROPHORESIS. Nagy, G. A. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem.; 18: 17-22(1970). (In Hungarian).

A method, developed for the identification and separation of carrier-free radioiodine in different states of valency is described. The separation is achieved by a combination of paper chromatography with paper electrophoresis. The R_f value, as well as the rate of displacement in paper electrophoresis, was established for each of the four chemical forms. The paper chromatographic experiments were performed on Schleicher-Schüll No. 6 fiber glass paper. (auth)

20803 RADIOLYSIS AND PHOTOLYSIS OF POLYPHENYL VINYLKETONE. David, C.; Demarteau, W.; Derom, F.; Geuskens, G. (Univ. of Brussels). Polymer; 11: 61-3(Jan 1970).

It is stated that valuable information concerning the mechanism of chain breaking or crosslinking under the effects of γ irradiation can be obtained by a comparative study of the photolysis and radiolysis of polymers. Studies are described on the effects of γ irradiation on PPVK. Main chain scission was previously found to occur when this polymer was uv irradiated. The γ irradiations were carried out in a ^{60}Co Gammacell, the intensity of which was 0.53 MR/hr, and the polymer was irradiated in sealed bulbs as a fine powder outgassed at room temperature. Molecular weights before and after irradiation were determined by viscosity measurements in benzene at 25°C. The molecular weight decreased under the influence of γ irradiation. The ir spectra remained unchanged even after absorption of 50 MR. The number of main chain scissions was calculated and is shown graphically as a function of dose; the number of scissions per 100 eV absorbed was found to be 0.35. The behaviour under γ irradiation was thus not in agreement with Miller's empirical rule (J. Polymer Sci. 14: 503 (1954)). It was also found that photochemical and radiochemical chain scissions of solid PPVK are to some extent inhibited by naphthalene and diphenyldisulphide. A strong inhibiting effect on the formation of acetophenone due to triplet energy transfer from the ketone to naphthalene was also observed for butyrophenone irradiated as a pure liquid. The results demonstrated the participa-

tion of radicals and of the excited n-* triplet state of the ketone group during the radiolysis and photolysis of PPVK. The Norrish type 2 scission most probably occurs by reaction of this triplet state for PPVK as for butyrophenone. Other scavengable radicals can also be formed which may be responsible for other types of chain breaking involving no triplet state. (UK)

20804 IRRADIATION-PRODUCED SOLVATED ELECTRONS IN ICE. Eiben, Klaus (Nuclear Research Center, Karlsruhe, Ger.). pp 184-94 of Physics of Ice. /Riehl, Nikolaus (ed.). New York; Plenum Press (1969).

From International Symposium on Physics of Ice, Munich, Germany. See CONF-680963.

Influences of the structure and the temperature on production and stability of solvated electrons formed as one of three reactive intermediates during the radiolysis of ice have been studied by several groups. Experimental evidence for the presence of radio-induced solvated electrons was established utilizing the techniques of ESR and optical spectroscopy as well as pulse-radiolysis. The stability of solvated electrons in ice is increased as the lattice of the ice structure is progressively destroyed. The production of solvated electrons in crystalline ice shows a remarkable temperature dependence. Their stability is small compared to those in alkaline ice glasses. This is explained by the very low concentration of pre-existing trapping sites for electrons in crystalline ice. A model of the solvation mechanism derived from the experimental results is discussed. (auth)

20805 ADVANCES IN RADIATION CHEMISTRY. VOLUME 1. Burton, Milton; Magee, John L. (eds.). New York; John Wiley and Sons, Inc. (1969). 409p. $16.50.

Four chapters are included; separate abstracts were prepared for 3. The remaining chapter contains information on the theory of transient negative ions of simple molecules. (P.C.H.)

For abstracts of individual chapters see: 20806–20808.

20806 CHARGED PARTICLE TRACKS AND THEIR STRUCTURE. Mozumder, A. (Univ. of Notre Dame, Ind.). Advan. Radiat. Chem.; 1: 1-102(1969). (COO-38-604).

The various aspects connected with charged particle tracks, especially in a condensed medium, are reviewed. In particular, the importance and repeated applications of track models in certain areas of radiation chemistry are discussed in a comprehensive manner. Information is included on: general conceptual framework; stopping power theory; thermalization phenomena; low-LET tracks; intermediate-LET tracks; high-LET tracks; electron escape; and dose rate effect. (120 references.) (P.C.H.)

20807 ELEMENTARY PROCESSES AND REACTIONS IN THE RADIOLYSIS OF WATER. Thomas, J. K. (Argonne National Lab., Ill.). Advan. Radiat. Chem.; 1: 103-98(1969).

A simple explanation of the initial energy loss to water by ionizing radiation is discussed. The conclusions reached support the production of large yields of positive ions and electrons from both direct ionization and possible excited states. Discussion is presented on: primary species; HO_2 radical reactions; radiolysis of water vapor; irradiation of ice; radiolysis of inorganic systems; solutions of organic molecules; and solutions of large molecules. (320 references.) (P.C.H.)

20808 CHEMICAL SYNTHESIS BY IONIZING RADIATION. Wagner, C. D. (Shell Development Co., Emeryville, Calif.). Advan. Radiat. Chem.; 1: 199-244(1969).

An attempt was made to catalog potential uses of ionizing energy in commercial synthetic processes, and also to point to classes of reactions initiated by ionizing radiation that can be useful to the research chemist in the laboratory. In that respect, only the synthesis of small inorganic and organic molecules is considered. Discussion is included on: advantages in the use of ionizing radiation; useful sources of ionizing radiation; economic principles of radiation synthesis; synthesis by chain reactions, with initiation by ionizing radiation; radioinduced reactions of low G-values; and fission recoil reactions. (225 references.) (P.C.H.)

20809 ELECTRON PARAMAGNETIC RESONANCE OF NICKEL ACETATE. IRRADIATION-INDUCED SPIN PAIRING. Morton-Blake, D. A. (National Physical Lab., Teddington, Eng.). J. Phys. Chem.; 74: 1508-11(2 Apr 1970).

Single crystals of x-irradiated nickel acetate tetrahydrate were investigated by EPR at 77°K. The spectra of several $S = \frac{1}{2}$ species were observed, indicating that one of the electron spins in the Ni^{3+} ion had paired with a free spin created in one of the ligands. Using a single mounting position of the crystal and assuming cylindrical g-tensor symmetry, a least-squares computation gave the components $g_{||} = 2.463 \pm 0.002$, $g_{\perp} = 2.076 \pm 0.002$ for the main species formed. However, there is some evidence for the presence of an appreciable rhombic component, which would introduce an uncertainty of 0.02 in $g_{||}$. (auth)

20810 AN ELECTRON PARAMAGNETIC RESONANCE STUDY OF Y-TYPE ZEOLITES. I. O_2^- ON ALKALINE EARTH ZEOLITES. Wang, Katherine M.; Lunsford, Jack H. (Texas A and M Univ., College Station). J. Phys. Chem.; 74: 1512-22 (2 Apr 1970).

Interactions between the adsorbed O_2^- species and alkaline earth Y-type zeolites were studied by means of EPR spectroscopy. The adsorbed O_2^- was formed by uv or γ irradiation of the zeolites in oxygen. The results show that there are three or more different adsorption sites on each of the cationic zeolites. The spectra were placed into three groups according to their g values and response to the two types of irradiation. Within each group there does not appear to be any significant trend in the energy splitting, Δ, of the $2p\pi_g^*$ levels of the O_2^- ion as one goes up the series from BaY to MgY. The CaY zeolite was also studied after extensive γ irradiation of the sample under vacuum. Three paramagnetic centers were also formed under these conditions; two were identified as V-type centers and the other as an F-type center. (auth)

20811 RADIOLYSIS OF LIQUID TRIFLUOROIODOMETHANE. McAlpine, I.; Sutcliffe, H. (Univ. of Salford, Eng.). J. Phys. Chem.; 74: 1422-5(2 Apr 1970).

The radiolysis of trifluoroiodomethane in the liquid phase at room temperature was examined. The products and 100-eV yields are tetrafluoromethane (0.37), hexafluoroethane (1.03), and iodine (1.36). Experiments in the presence of oxygen and nitric oxide as radical scavengers indicate that the reaction proceeds mainly by a radical process. (auth)

20812 RADIOLYSIS OF LIQUID NITROMETHANE. Corey, James L.; Firestone, Richard F. (Ohio State Univ., Columbus). J. Phys. Chem.; 74: 1425-31(2 Apr 1970).

Initial 100-eV yields and effects of dose on the rates of formation of 12 products from the ^{60}Co γ-induced decomposition of pure, air-free, liquid nitromethane were measured at constant dose rate (9×10^{17} eV/g min) at 0°C and at room temperature. The cis dimer of nitrosomethane, methyl nitrite, and formaldehyde are major initial products at both temperatures. Initial yields of formaldehyde and methyl nitrite exhibited pronounced positive temperature coefficients. Neither the trans dimer of nitrosomethane nor nitrogen dioxide was found among the final products. A relatively slow, thermal, dark reaction converts nitrosomethane to methyl nitrite at room temperature, but not at 0°C. Effects of increasing dose at room temperature are similar to those of the dark reaction. A mechanism invoking the existence of the intermediate $CH_3(NO)_3$ is proposed to account for effects of dose. (auth)

20813 POSITIVE IONS OF γ-IRRADIATED HYDROCARBONS AT 77°K. Louwrier, Pieter W. F.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 74: 1418-21(2 Apr 1970).

Radical positive ions RH^+ were prepared by γ irradiation of several alkanes (~0.5 mol %) in 3-methylpentane (3MP) and carbon tetrachloride matrices at 77°K, and their optical absorption spectra were measured. These ions were not observed in matrices of alkanes higher than C_6H_{14}, nor in one-component systems (with CO_2 as electron trap). The yield of RH^+ was much less in 2-methylpentane than in 3MP, which has the lower viscosity and depends also on the ionization potential of the scavenger for a series of alkyl chlorides. The rate of dark decay of RH^+ increased with concentration of RH and with temperature in the range 62 to 77°K. The quantum yield of bleaching increased with frequency and diminished with progressive bleaching. The yield of $C_6H_7^+$ in 3MP attained a pronounced maximum at 2 vol %, similar to several RH^+ in 3MP, and attributed to charge recombination via positive hole tunneling. (auth)

20814 MOLECULAR WEIGHTS OF GRAFTED POLYSTYRENE ONTO γ-PREIRRADIATED CELLULOSE DIACETATE. Munari, Stelio; Tealdo, G. Carlo; Canepa, Giacomo; Rossi, Corrado (Univ., Genoa). J. Appl. Polym. Sci.; 14: 807-16(Mar 1970).

The behavior of molecular weights of grafted polystyrene onto γ-preirradiated cellulose diacetate was studied. The grafting of styrene onto cellulose diacetate was kinetically followed with particular attention paid to the polystyrene molecular weight behavior. The molecular weight was evaluated with the polymer fractions obtained by acid hydrolysis of the grafted copolymer. From the experimental results it appeared that the grafted chain molecular weight was completely controlled by the physical properties of the polymeric matrix either during a "bulk" or a "front" grafting. (auth)

20815 CELLULOSE GRAFT COPOLYMERS. II. GRAFT COPOLYMERIZATION OF ETHYL ACRYLATE WITH γ-IRRADIATED CELLULOSE FROM ACETONE–WATER SYSTEMS. Nakamura,

Yoshio; Hinojosa, Oscar; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Appl. Polym. Sci.; 14: 789-97(Mar 1970).

Ethyl acrylate was graft-copolymerized from acetone–water systems with γ-irradiated, purified cotton cellulose. The scavenging of the free radicals in the irradiated cellulose by water, acetone, and water–acetone systems was determined by electron spin resonance spectroscopy. The ESR spectra of free radicals, scavenged by water and acetone, were recorded by the use of a time-averaging computer attached to the ESR spectrometer, in which the ESR spectrum of the irradiated cellulose, which had been immersed in water and/or acetone, was electronically subtracted from the ESR spectrum of the irradiated cellulose control. For both water and acetone, the ESR spectra of the scavenged free radicals were singlets. This indicated that free radical sites formed on carbon C_1 or C_4 on radiation-initiated depolymerization, which would generate singlet ESR spectra, were readily accessible to these solvents. The maximum scavenging of the radicals was observed when irradiated cellulose was immersed in acetone–water solution which had a composition of 25/75 vol-%. The scavenging of the free radicals in irradiated cellulose when immersed in acetone–water solutions was less than when immersed in methanol–water solutions. Also, the extent of graft copolymerization of ethyl acrylate from acetone solutions with irradiated cellulose was less than that of ethyl acrylate from methanol solutions. These differences were probably due to differences in the diffusion rates of acetone and methanol into the cellulosic structure of ethyl acrylate from acetone solutions with irradiated be less than in the methanol solutions, since acetone is a better solvent for poly(ethyl acrylate) than methanol. (auth)

20816 EFFECTS OF DISSOLVED OXYGEN ON THE ELECTRON SPIN RESONANCE SIGNAL INTENSITIES OF TRAPPED HYDROGEN ATOMS AND SOME OF THEIR REACTIONS IN ACIDIC ICE MATRICES. Holmes, D. E.; Nazhat, N. B.; Weiss, J. J. (Univ. of Newcastle-upon-Tyne, Eng.). J. Phys. Chem.; 74: 1622-6(2 Apr 1970).

Electron spin resonance spectra of irradiated acidic ices saturated with oxygen and nitrogen show that the formation and the yields of trapped hydrogen atoms at 77°K are practically independent of dissolved oxygen while their ESR signal intensities are dependent, under certain conditions, on the oxygen content and the applied microwave power. During annealing of irradiated ices containing thymine and oxygen at 100°K, hydrogen atoms react to form thymine hydrogen atom adduct radicals and hydroperoxide radicals. On annealing to 175°K, oxygen reacts with the thymine hydrogen atom adduct radicals to form 5,6-dihydrothymyl peroxide radicals. These reactions of hydrogen atoms and oxygen, in irradiated ices at 77 to 195°K, are discussed in relation to similar reactions in the liquid phase. (auth)

20817 MOLECULAR OXYGEN AS AN ELECTRON TRAP IN THE THERMOLUMINESCENCE OF SATURATED HYDROCARBONS. Boustead, I. (Royal Military Coll. of Science, Shrivenham, Eng.). Nature (London); 225: 846-7(28 Feb 1970).

Molecular oxygen participates in organic thermoluminescence both as an electron trap and as a luminescence quencher. It was shown by Charlesby and Partridge that when molecular oxygen is present in polyethylene the thermoluminescence glow curve produced by warming samples previously subjected to low-temperature gamma radiolysis showed an additional glow peak, which disappeared when molecular oxygen was removed, suggesting that the peak originated in electron trapping on the oxygen molecules. The new results described cover not only a wide range of low and high density polyethylenes but also a series of saturated hydrocarbons having five to 20 main chain carbon atoms. Measurements were made using a technique the essential features of which were a controlled slow rate of warming (3°K/min) and careful measurements of the sample temperature. In the case of the paraffin hydrogens trace quantities of anthracene were added to provide the necessary luminescence centers. All samples of polyethylene showed the oxygen glow peak at 145 ± 4°K, independent of molecular weight, degree of branching, and degree of crystallinity. The glow curves of the low-molecular-weight paraffins showed a number of glow peaks the temperatures of which are tabulated, but no oxygen peak was observed in paraffins having an odd number of main chain C-atoms. It was also found that the temperature at which the oxygen peak occurs in the even paraffins decreases with increasing molecular weight. This difference between the even and odd paraffins is also reflected in a number of other physical properties, and is thought to originate in their different crystalline structures. The way in which molecular oxygen acts as an electron trap is discussed. The fact that theory indicates a considerably higher temperature for the molecular oxygen glow peak than experimentally observed values implies that the trap depth in saturated hydrocarbons is reduced from the electron affinity of oxygen to the observed value by an interaction between the matrix and the oxygen molecules. If such an interaction were dependent on molecular weight, then the variation would be expected to be greater at low molecular weights, as the relative change produced by the addition of an extra main carbon is proportionally greater in the low-molecular-weight range. At some chain length, however, the properties of the even and odd paraffins must converge, and it was found that a weak oxygen peak appeared at about 152°K in odd-carbon highly purified $C_{25}H_{72}$. The results are consistent with the view that electron trapping occurs on molecular oxygen by the formation of O_2^- and that the trap depth is given by the electron affinity of molecular oxygen reduced by a factor determined by the matrix-oxygen interaction energy, which is dependent on molecular weight. The exact nature of the interaction forces is difficult to ascertain, but some qualitative deductions are made, and further studies are in hand with a view to ascertaining their exact nature. (UK)

20818 INTERSYSTEM CROSSING IN IRRADIATED BENZENE AND TOLUENE. Cundall, R. B.; Tippett, W. (Univ. of Nottingham, Eng.). Trans. Faraday Soc.; 66: 350-62(Feb 1970).

By use of the photosensitized (254 nm) cis-trans isomerization of butene-2 the triplet yields in liquid benzene and toluene at 25°C were measured; they are 0.57 and 0.45. Internal conversion efficiencies are about 0.41 (benzene) and 0.48 (toluene). The effect of added xenon is to increase the triplet yield of benzene to unity. From these and similar experiments on the γ-induced isomerization the rate constants for the $^1S \rightarrow {}^3S$ and $^3S \rightarrow S$ processes in benzene catalyzed by the spin orbit coupling effect of xenon were deduced to be $2 \times 10^8\ M^{-1}\ s^{-1}$ and $3 \times 10^8\ M^{-1}\ s^{-1}$, respectively. There is evidence that xenon has an effect on ionic and other processes in the high-energy radiation-induced isomerization experiments. The application of benzene and toluene as organic photosensitizers is discussed. (auth) (UK)

20819 INFLUENCE OF γ-IRRADIATION ON PANTHENOL AND CALCIUM PANTOTHENATE IN AQUEOUS SOLUTION. Washuettl, J. (Technische Hochschule, Vienna). Mikrochim. Acta; No. 1, 164-7 (1970). (In German).

By means of a thin layer chromatographic procedure, an investigation was made of the decrease of calcium pantothenol in aqueous solutions following γ irradiation. It was found that calcium pantothenate was markedly decomposed beginning at 500 Krad and pantothenol only from 1 Mrad. (auth)

20820 γ-IRRADIATION EFFECTS ON THE THERMAL STABILITY AND DECOMPOSITION OF AMMONIUM PERCHLORATE. Fogler, Scott (Univ. of Michigan, Ann Arbor); Lawson, David. J. Phys. Chem.; 74: 1637-9 (2 Apr 1970).

Studies were conducted on the decomposition of γ-irradiated and unirradiated ammonium perchlorate at temperatures around 135°C. On exposure to γ radiation, the induction time of the reaction decreased with increasing irradiation time up to 1000 sec. The induction time was directly proportional to the log of the irradiation time for samples that were irradiated less than 1000 sec. (M.C.G.)

20821 HYDROGEN-BOND EFFECT IN THE RADIATION RESISTANCE OF CHLORAL HYDRATE TO γ RAYS. Milia, F. K.; Hadjoudis, E. K. (Democritos Nuclear Research Center, Athens). J. Phys. Chem.; 74: 1642-3(2 Apr 1970).

The effect of hydrogen bond on the radioresistance of chloral hydrate was investigated. The damage was larger when measured at 37.513 Mcps than at 38.699 or 38.784 Mcps. This is attributed to the different type of chemical bonding to the chlorine atoms. (M.C.G.)

20822 THERMOLUMINESCENCE IN SQUALANE. Boustead, I.; Charlesby, A. (Royal Military Coll. of Science, Shrivenham, Eng.). Proc. Roy. Soc. (London), Ser. A; 315: 271-86(24 Feb 1970).

Squalane (hexamethyltetracosane) freezes to a rigid amorphous glass. Phosphorescence measurements showed two transitions, at 110 and 147°K, while thermoluminescence following γ irradiation at 77°K gave a glow curve consisting of four distinct peaks, one of which can be associated with the presence of molecular oxygen in the sample. The three remaining peaks coincide with the two-phase transitions mentioned above and the melting point. Dose kinetics showed the existence of two types of traps and led to a simple model for the thermoluminescence mechanism. A tentative identification of the luminescence centres was made. (auth) (UK)

20823 BONDING OF SMALL MOLECULES TO DNA FOLLOWING IONISING RADIATION. Byfield, J. E.; Lee, Y. C.; Bennett, L. R. (Univ. of California, Los Angeles). Nature (London); 225: 859-60(28 Feb 1970).

It was found that 6-MeV electron irradiation of DNA systems in solution or in chromatin can bring about the formation of covalent links between the DNA molecules and a variety of small molecules.

Purified commercial calf thymus DNA and DNA purified from Tetrahymena pyriformis were used in the studies, and in order to determine the chromatographic properties of the irradiation products some DNA samples were irradiated directly with 10^6R in the presence of a mixture of ^{14}C-amino acids. In the case of tritiated leucine and various concentrations of DNA, conversion of label from acid solubility to acid insolubility was proportional to the DNA concentration and to the amount of absorbed radiation. In other studies it was found that a variety of small molecules, including thyroxine, glyceraldehyde and other amino acids, was also bound following irradiation. Similar results were obtained when DNA was replaced by RNA or albumin when the irradiated DNA was hydrolysed and chromatographed the label was found to be distributed over the entire chromatogram, and examination of the chromatograph under uv light showed only the expected four nucleotides. The irradiation products therefore probably existed only in minute amounts and included a wide variety of compounds. The label was not localized on the chromatograph even when single amino acids were used as the labeled source. In other experiments it was found that label (^{14}C-d-phenylalanine) can be bound to DNA existing as native chromatin. It was again found that label was associated with material which was acid insoluble following irradiation and which could be concentrated using standard DNA purification procedures. The studies strongly indicated that small amounts of amino acids and carbohydrates can become covalently linked to nucleic acids following ionizing irradiation. The data suggest, however, that the reactions are chemically non-specific. It seems reasonable to assume that similar reactions occur in vivo. Because of the possible genetic implications it would seem important to determine whether associated lesions can be repaired in the same fashion as pyrimidine dimer excision; products resistant to repair excision might act as mutagens. (UK)

20824 RADICALS PRODUCED DURING γ-IRRADIATION OF 1-SUBSTITUTED 5-AMINOTETRAZOLES. Butler, R. N.; Catton, R. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., B; No. 2, 378-80(1970).

The 1-methyl site of alkyl substituted 5-aminotetrazoles was found to be the most susceptible to γ irradiation. The main paramagnetic radicals formed were identified as $CH_3^{\cdot}$ and $R\text{-}CH_2^{\cdot}$ (R = substituted 5-aminotetrazole). With a 5-nitramino–tetrazole clearage of the nitramino N–N band, yielding an $NO_2^{\cdot}$ radical was the major reaction. (auth) (UK)

20825 RADIATION-CHEMICAL TELOMERIZATION OF ETHYLENE WITH METHYL FORMATE. Bryantsev, I. N.; Zagorets, P. A.; Romina, N. N.; Terent'ev, A. B.; Freidlina, R. Kh. (Inst. of Elemental Organic Compounds, Moscow. Chemical-Technological Inst., Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 1, 169-71(Jan 1970). (In Russian).

The radiation-chemical telomerization of ethylene with methyl formate was studied in the temperature range from 125 to 190°C. Regrouping of the radicals with 1, 6-migration of the hydrogen atom occurred in the reaction process. (tr-auth)

20826 FORMATION OF DESOXYSACCHAROSE ON IRRADIATION OF AQUEOUS SOLUTIONS OF CARBOHYDRATES. Kochetkov, N. K.; Kudryashov, L. I.; Yarovaya, S. M.; Voznesenskaya, S. V. (Inst. of Organic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 1, 201-2(Jan 1970). (In Russian).

Formation of deoxysaccharose is the general process observed on irradiation of aqueous solutions of carbohydrates and carbohydrate-containing polymers under different conditions. The results permit the assumption that the formation of deoxy compounds requires the participation of e_{aq}^- and O_2^- and deoxy keto compounds are formed basically with the participation of the OH radical. (tr-auth)

20827 THE DIELECTRIC CONSTANT OF DIPOLAR SUBSTANCES IN THE ENVIRONMENT OF IONS PRODUCED BY IRRADIATION. Schiller, Robert (Central Research Inst. for Physics, Budapest). Chem. Phys. Lett.; 5: 176-8(15 Mar 1970).

The time behavior of the dielectric constant of dipolar substances polarized exclusively by the ions within the system is described by a simple exponential function. The dielectric constant varies only with the time elapsed after the formation of the ions. (auth)

20828 STUDY OF RADIOACTIVE MAGNESIUM SULFATE CATALYSTS BY THE METHOD OF ELECTRON PARAMAGNETIC RESONANCE (EPR). Pomogaibin, A. G.; Kotov, A. G.; Mikhailenko, I. E. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 189: 1298-1301(21 Dec 1969). (In Russian).

Studies were made to determine whether or not paramagnetic centers exist in irradiated $MgSO_4$ at temperatures of 300 to 420°C that would have an effect on the catalytic activity of this compound in dehydrating aliphatic alcohols. EPR spectral studies were made on freshly prepared radioactive samples of $MgSO_4$ having specific activities of 40 and 80 mC/g, and on samples with initial specific activity of 170 and 640 mC/g which had been stored greater than one year. These spectra showed the presence of the SO_2^-, SO_3^-, and SO_4^- ion-radicals. It was concluded that the SO_2^- ion-radical is responsible for the decrease in the catalytic activity of magnesium sulfate in alcohol dehydration on neutron irradiation. (TTT)

20829 KINETICS OF THE RADIATION–CHEMICAL OXIDATION OF TRICHLOROETHYLENE. Puluektov, V. A.; Mekhryushev, Yu. Ya. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 189: 1268-70(21 Dec 1969). (In Russian).

Oxidation of trichloroethylene (TCE) was carried out at 30 to 70°C by passing 0.4 liters of oxygen per minute through 100 ml TCE and irradiating with ^{60}Co gamma rays at dose rates of 25 to 230 rads/sec. By chromatography it was found that the main reaction products are trichloroethylene oxide, the chloranhydride of dichloracetic acid (the oxide isomer), and a small amount of phosgene (not more than 3% of the weight of the initial material). The accumulation of the oxide and chloranhydride is linear with time at constant dose rate, temperature, and oxygen supply. These compounds form independently of each other with more oxide being formed than chloranhydride. The chain reaction rate depends on the dose rate, and constants are presented to calculate G-values for different temperatures and dose rates. The reaction mechanism is discussed. (TTT)

20830 THEORETICAL CONSIDERATION OF L,E,T, AND ENERGY EFFECTS OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. Tabata, Yoneho; Oshima, Keichi (Tokyo Univ.). J. Fac. Eng., Univ. Tokyo, Ser. B; 30: No. 2, 167-73 (Sep 1969).

Polymerization of acrylonitrile in the solid state at low temperatures is profoundly affected by energy of incident electrons, and the rate of polymerization increases with the energy of electrons in an energy region of 10 to 20 MeV. A theoretical treatment involving impact parameter distribution of energy primarily transferred by incident charged particles to the medium as calculated by Watanabe is applied to explain the energy effects. From the calculation, it is clear that the excitation can be induced more homogeneously by high energy electrons than by low energy electrons. Therefore, if the polymerization is inhibited by overlapping of excited regions, above a certain value of the density of excited species, the energy effect by which the rate of reaction is profoundly affected can be explained by the homogeneity of excitation by accelerated electrons in the energy range from 10 to 20 MeV. (auth) (NSA of Japan)

20831 THIN FILLER AS RADIATION-INDUCED GRAFT-POLYMER OF VINYL MONOMER. Higashide, Fukuji; Kanazawa, Yoshiko (Shizuoka Coll. of Pharmacy, Japan). Kogyo Kagaku Zasshi; 73: 105-10(Jan 1970). (In Japanese).

The radioinduced graft-polymerization of vinyl monomers was carried out in the presence of flaky thin glass in order to obtain effective thin fillers having affinity to polymers. Polymerization of methyl methacrylate on alumino–silicate glass occurred readily when the glass was previously treated with $K_2Cr_2O_7$–H_2SO_4 solution. If an alkaline silicate or silica was used, grafting was not observed. IR spectra, gas chromatograms, weight loss on heating, and DTA of the pyrolyzate were used to identify grafting. ESR spectra were also taken to investigate the defects produced in the glass by γ irradiation to clarify the mechanism of the graft-polymerization. The spectrum of irradiation alumino–silicate glass pretreated with the mixed acids showed lines with six hfs peaks spaced equally with peaks separated by 20.6 G. It was concluded that the defect was an electron center trapped at the three-coordinated aluminum formed by loss of one oxygen atom from the tetrahedron coordinated AlO_4 lattice. Further ESR investigation of the preirradiation process was undertaken to determine if the radioinduced defect in alumino–silicate glass was the initiating point of the graft-polymerization. The effect of chromium ions on the graft-polymerization is also discussed. (auth) (NSA of Japan)

20832 FERMENTATION PROCESSES. Ito, Hitoshi; Iizuka, Hiroshi; Shibabe, Sadami (to Japan Atomic Energy Research Inst.). British Patent 1,184,514. 18 Mar 1970. Priority date 21 Apr 1967, Japan.

Mashes for fermentation or their precursors can be sterilized by 10^4 to 10^6R of γ rays, accelerated electron beams, or x rays. The method is particularly suitable for sterilization of mashes of molasses and water to be fermented to alcohol. (B.L.M.)

20833 COMPARISON OF THE RECOIL REACTIONS IN THE ^{80m}Br–CH_4 AND ^{82m}Br–CH_4 SYSTEMS. Tachikawa, Enzo (Japan

Atomic Energy Research Inst., Ibaraki). Bull. Chem. Soc. Jap.; 43: 63-7(Jan. 1970).

The reactions of ^{80}Br and ^{82}Br excited by the isomeric transition processes with CH_4 were compared. Similar reaction processes; energetic and thermal ionic, are involved in both cases. However, the isotope effect appears in the energies process to form CH_3Br, but not in the thermal ionic process to form CH_3Br and CH_2Br_2. The difference in the γ transitions of ^{80m}Br and ^{82m}Br to the ground states is responsible for the above results. It was concluded that at least a part of the recoil Br atoms enter chemical combinations with surrounding molecules within 10^{-5} sec, the lifetime of the excited ^{80}Br atom. Furthermore, the yield of $CH_3{}^{80}Br$, lower than that of $CH_3{}^{82}Ba$, is discussed on the basis of the different kinetic energies achieved on the Br atoms. (auth)

20834 THE OXIDATION STATE OF ^{126}I ARISING FROM THE (n,2n) REACTION IN INORGANIC IODINE COMPOUNDS. Saito, Nobufusa; Ambe, Fumitoshi (Inst. of Physical and Chemical Research, Saitama, Japan). Bull. Chem. Soc. Jap.; 43: 282-4 (Jan 1970).

Potassium iodate, $KH(IO_3)_2$, I_2O_5, and $NaIO_4$ were irradiated with fast neutrons and the distribution of the ^{126}I produced by the $^{127}I(n, 2n)^{126}I$ reaction among various oxidation states was determined. The results are compared with literature data on ^{128}I from the $^{127}I(n,\gamma)^{128}I$ reaction. (B.L.M.)

20835 POLYMERISATION OF OLEFINS. (to Japan Atomic Energy Research Inst.). British Patent 1,183,501. 11 Mar 1970. Priority date 19 Apr 1966, Japan.

A method is described for polymerizing olefins alone or with another polymerizable monomer by means of a radical initiator ionizing radiation in the presence of CO_2 or CO_2 and another organic medium, which do not take part in the polymer. Carbon dioxide is present in 5 to 60 mole % based on the olefin. The radiation may be either alpha rays, beta rays, γ rays, x rays, or neutron beams. The process is particularly suited to the polymerization of ethylene. (B.L.M.)

20836 RADIATION POLYMERIZATION OF ETHYLENE. (to Japan Atomic Energy Research Inst.). British Patent 1,183,502. 11 Mar 1970. Priority date 3 Aug 1966, Japan.

A two-stage radiation process is described for the polymerization of ethylene in the presence of CO_2. The reaction mixture is irradiated at a dose rate of 10^4 to 10^6 R/hr at a temperature <60°C to initiate the polymerization. The second-stage irradiation is carried out at a dose rate of 50 to 5000 R/hr and at a temperature of <120°C, the melting point of polyethylene, and is intended for the growth of the polymers. The preferred types of radiation are beta, γ, or electrons. (B.L.M.)

20837 PROCESS FOR MANUFACTURING PRODUCT OF CROSS-LINKABLE POLYMERIC MATERIAL. (to Firestone Tire and Rubber Co.). British Patent 1,183,693. 11 Mar 1970. Priority date 23 Aug 1967, United States.

A process for manufacturing a product from a cross linkable polymeric material comprises shaping the material in the uncured state, lowering the temperature of the shaped article so as to subject it to a second-order transition to convert it to a glass-like state, and crosslinking the glass-like material by subjecting it to ionizing radiation. Cooling baths of liquified gases or mixture of alcohol and CO_2 used on a continuous conveyor system serve to lower the temperature of the shaped article, which may be either an elastomer or a plastic. The radiation may be either electrons or γ radiation. (B.L.M.)

20838 EFFECTS OF ALKYL HALIDES ON THE γ-RAY INDUCED POLYMERIZATION OF ETHYLENE IN LIQUID CARBON DIOXIDE. Hagiwara, Miyuki; Okamoto, Hidemasa; Kagiya, Tsutomu (Japan Atomic Energy Research Inst., Gumma). Bull. Chem. Soc. Jap.; 43: 172-7(Jan 1970).

The ^{60}Co γ-induced polymerization of ethylene in a liquid CO_2 solvent was carried out under a pressure of 400 kg/cm^2 at 30°C in the presence of such alkyl halides as CH_2Cl_2, $CHCl_3$, CCl_4, C_2H_5Cl, C_2H_5Br, C_2H_5I, $C_2H_4Cl_2$, $C_2H_2Cl_4$, C_2Cl_6, C_2F_6, C_2F_5Cl, $C_2F_4Cl_2$, $C_2H_3Cl_3$, and $C_2F_3Cl_4$; and their effects on the polymerization rate and the molecular weight of the polymer formed were investigated. Both the rate and the molecular weight were increased by adding $C_2F_4Cl_2$, C_2F_5Cl, and C_2F_6. A study of the radiolysis of these three fluorocarbons by mass spectrometric analysis showed that bond scissions of these substances took place mainly at the C–C bond. When other halogen compounds besides the three fluorocarbons were added to the reaction mixture, the rate and the molecular weight were decreased and C–X (X : halogen) bond scission was predominant in those substances. On the basis of these results, the role of the additives in the polymerization was discussed in relation to their radiolysis reactions. (auth)

20839 DOSE-RATE DEPENDENCY OF THE RADIATION-INDUCED POLYMERIZATION OF ETHYLENE IN AN AQUEOUS SOLUTION OF tert-BUTYL ALCOHOL. Senrui, Shiro; Kurihara, Hirondo; Takehisa, Masaaki (Japan Atomic Energy Research Inst., Gumma). Bull. Chem. Soc. Jap.; 43: 294(Jan 1970).

The rate of polymerization of ethylene in tert-butyl alcohol and water was investigated with respect to time and dose rate. Initially, polymerization increased with increasing time and then became independent of time. In the latter stage, the rate of polymerization was proportional to the square root of the dose rate. An equation is given for the polymerization rate. From both theoretical considerations and experimental results it is obvious that the variation of the polymerization with dose rate cannot be explained by a monomolecular termination mechanism alone, indicating that the bi-molecular termination process plays an important role. (B.L.M.)

20840 THE CATALYTIC ACTIVITY OF NEUTRON-IRRADIATED NICKEL FOR HYDROGENATION. Yoshino, Tomio (Tokushima Univ., Japan). Nippon Kagaku Zasshi; 91: 86-7(Jan 1970). (In Japanese).

The catalytic activity of neutron-irradiated Ni annealed at 600°C in hydrogen atmosphere before irradiation, was about 3 times as much as nonirradiated Ni in hydrogenation of acetone. When the catalyst was sintered at 110 to 200°C, its activity caused by neutron irradiation entirely disappeared. It is concluded that because the hydrogenation activity decreases in the temperature range in which point defects in Ni vanish, the active centers of the catalyst are closely related with point defects generated by irradiation. (auth)

20841 STRUCTURE AND REACTIVITY OF $C_4H_8^+$ IONS FORMED IN THE RADIOLYSIS OF CYCLOALKANES IN THE GAS PHASE. Lias, S. G.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Amer. Chem. Soc.; 92: 1840-7(8 Apr 1970).

The structure and reactivity of the $C_4H_8^+$ formed in the fragmentation of cyclohexane and methylcyclopentane parent ions has been examined ($[C_6H_{12}^+]^* \rightarrow C_2H_4 + C_4H_8^+$). It is noted that $C_4H_8^+$ consists of 1-$C_4H_8^+$, i-$C_4H_8^+$, and 2-$C_4H_8^+$. The relative abundances of these isomer ions depend on the energy content of the cycloalkane ion. According to the mass spectral cracking pattern of cyclohexane-1,1,2,2,3,3-d_6 the high energy parent ion splits out $C_4H_8^+$ without extensive prior rearrangement. The $C_4H_8^+$ so formed is analogous to the $C_4H_8^+$ ion produced in the photoionization or radiolysis of cyclobutane. The various $C_4H_8^+$ isomers react with the cycloalkanes by acceptance of an H_2^- entity: $C_4H_8^+ + C_6H_{12} \rightarrow C_4H_{10} + C_6H_{10}^+$. The relative reaction rates, which were determined by means of isotopic labeling experiments, differed widely with a change in the structure of both the reactant ion and the reactant molecule, with the rate of reaction being generally higher for the more exothermic process. (auth)

Radiochemistry

Refer also to abstract 20833.

20842 MOESSBAUER STUDIES OF AFTER-EFFECTS OF AUGER IONIZATION FOLLOWING ELECTRON CAPTURE IN COBALT COMPLEXES. Nath, A. (Univ. of California, Berkeley); Klein, M. P.; Kuendig, W.; Lichtenstein, D. Radiat. Eff.; 2: 211-34(Feb 1970).

The electron-capture decay of a ^{57}Co atom triggers an Auger event resulting in the loss of several electrons from the molecule in which it is incorporated. The 14.4-keV Moessbauer emission conveys information regarding the chemical forms in which the daughter iron-57 is "stabilized" within 10^{-7} sec following electron capture. During this time, the electronic relaxation occurs completely and several tens of electron volt energy is deposited in the molecule as a result of neutralization. It is found that the ethylenediamine tetraacetate, bis-salicylaldehyde triethylenetetramine, acetylacetone, and indenyl chelates fragment in a large majority of events, resulting in the formation of degraded ionic Fe^{2+} and Fe^{3+} in the former cases and $C_9H_7Fe^+$ in the latter. On the other hand, highly conjugated compounds such as cobalt phthalocyanine and Vitamin B_{12} escape fragmentation in 100 per cent of the Auger events. Tris-dipyridyl Co(III) perchlorate also escapes fragmentation in a majority of events. Apparently, the large amount of excitation energy deposited in the molecule as a consequence of charge neutralization is very rapidly (in less than 10^{-13} sec) and efficiently dispersed through neighboring molecules. When the dipyridyl chelate molecules are dispersed in a foreign matrix, the dissipation of charge and energy is no longer rapid and efficient and the probability of fragmentation is considerably enhanced. It is also found

that part of the coordinated parent species, in the case of labeled dipyridyl chelate, arises through fragmentation followed by interaction of electronically excited degraded iron species with a neighboring chelate molecule resulting in replacement of cobalt with an iron atom. This finding was made possible by using the chelate doped with "carrier-free" ^{57}Co citrate. Emission spectroscopy yields values for the isomer shifts and quadrupole splittings which differ somewhat from those obtained by absorption spectroscopy. The apparent disparities are attributed to the dissimilarities of the matrices in which the Moessbauer emitter or absorber is situated. (auth)

Separation Processes

Refer also to abstracts 20684, 20698, 20702, 20703, 20708, 20719, 20725, 20742, 20743, and 22423.

20843 (BARC-454) REMOVAL OF RADIOISOTOPES FROM LIQUID WASTES BY SORPTION ON LOCAL MINERALS. Chandra, Umesh (Bhabha Atomic Research Centre, Bombay (India)). 1970. 29p. Dep. CFSTI (U. S. Sales Only).

Various naturally occurring minerals available in India were extensively investigated for their suitability for treatment of radioactive liquid wastes at Trombay. Four general classes of sorbents were taken up for study and chiefly among the minerals are vermiculite, attapulgite, bentonite and lignite-type coal products. It was concluded that though vermiculite has been widely used as fixed bed ion exchange material, attapulgite too is a very potential mineral because of its exceptionally high selectivity for radiocesium even in presence of macro amounts of inactive sodium in the waste solutions. (auth)

20844 (BNWL-1046) THE IODINE COLLECTION EFFICIENCY OF ACTIVATED CHARCOAL FROM HANFORD REACTOR CONFINEMENT SYSTEMS: METHYL IODIDE RETENTION BY ACTIVATED CHARCOAL. Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1969. Contract AT(45-1)-1830. 27p. Dep. CFSTI.

Activated charcoal is used in the gas confinement system of Hanford's nuclear reactors and it is necessary that their iodine adsorption ability be precisely determined to ensure operational safety. Adsorption measurements were taken while subjecting these charcoals to stress. The results were compared with those obtained from new, unused products, and an estimate was made of the loss in iodine trapping efficiency. Adsorption tests, using both methyl iodide and iodine, were also conducted on fresh charcoal to measure the effectiveness of some of the newer commercially available products. The purpose of these tests was to aid in the selection of activated charcoal for replacement in the reactors or for use in future reactor confinement systems. The quantity of iodine emanated as methyl iodide during an accidental reactor meltdown is not accurately known; however, it is desirable to have a confinement system with sufficient capability for its removal. A stainless-steel facility was constructed for the purpose of testing the activated charcoals of interest. The charcoal was subjected to high humidity and temperature in this facility while its adsorption characteristics were measured for various concentrations and species of iodine. Results of measurements made on charcoal from all operational and shut-down reactors at Hanford showed severe deterioration in some. In certain cases as much as 20% of the molecular iodine was not adsorbed by a 1 in. bed of charcoal. Methyl iodide tests on unused activated charcoal illustrated that good adsorption was obtained only in those products specially treated to improve their trapping ability for this species. (auth)

20845 (BNWL-CC-2346(Rev.)) CONSISTENCY EVALUATION OF ACCOUNTABILITY DATA FOR A CHEMICAL PROCESSING PLANT. Christensen, D. E.; Schneider, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 18 Nov 1969. Contract AT(45-1)-1830. 37p. Dep. CFSTI.

Accountability data collected during the normal dissolution of irradiated fuel at a chemical reprocessing plant were evaluated. Results important to safeguarding nuclear materials are presented. (auth)

20846 (CEA-R-3744) RECOVERY OF TRANS-PLUTONIUM ELEMENTS. Espie, Jean-Yves; Poncet, Benjamin; Simon, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 147p. (In French). Dep. CFSTI (U. S. Sales Only).

The recovery of americium and curium in the fission product solutions obtained from the reprocessing of U-Al-Si-Fe fuels was studied. The fuel elements were subjected to an average irradiation of 4000 MW days/ton in a gas-graphite type reactor having a thermal power of 3.7 MW/ton of uranium. The process used consists of 3 extraction cycles and of an americium-curium separation. The actinides and the lanthanides are separated by an extraction cycle in 40 per cent TBP. The actinides are separated from the lanthanides by an extraction cycle in 8 per cent D2EHPA. The actinides are concentrated by an extraction cycle in 40 per cent TBP. The americium-curium separation is made by precipitation. (France)

20847 (DOCKET-50332-9) BARNWELL NUCLEAR FUEL PLANT. Addendum No. 8 to Safety Analysis Report. (Allied-Gulf Nuclear Services, Florham Park, N. J.). 9 Apr 1970. 213p. Dep. CFSTI.

The second-phase subsurface study at the site for the Barnwell plant was carried out and investigation procedures are described. Drilling logs, laboratory test results, and conclusions are given. It was concluded that no evidence was found to indicate the presence of voids or calcareous material in the zone between depths of 115 and 165 feet. (M.C.G.)

20848 (K-1787) ENGINEERING DEVELOPMENT OF AN ABSORPTION PROCESS FOR THE CONCENTRATION AND COLLECTION OF KRYPTON AND XENON. Fifth Summary Progress Report, January-June 1969. Merriman, J. R.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 1 Apr 1970. Contract W-7405-eng-26. 16p. Dep. CFSTI.

A selective process for removing krypton and xenon from contaminated gas streams by preferential dissolution in a fluorocarbon solvent is being developed at the Oak Ridge Gaseous Diffusion Plant. The technique being studied is a continuous absorption-stripping process. Pilot plant demonstration of this process forms the major part of the ORGDP program, although conceptual plant design work and process optimization studies supplement the experimental effort. The first phase of the testing program, in which refrigerant-12 was used as the process solvent, was successfully completed. Pending further definition of process application guidelines, the conceptual plant design part of the project was temporarily suspended. The optimization studies were continued, however, with the investigation of an absorption plant suitable for removing the krypton and xenon that might be present in the argon cover gas of a vented fuel breeder reactor. (auth)

20849 (KFK-907) DESCRIPTION OF A CONTROL EXPERIMENT IN THE EUROCHEMIC REPROCESSING FACILITY. Kraemer, R.; Baeckmann, A. v.; Hagen, A.; Nentwich, D.; Coerdt, W.; Otto, H. E. (Kernforschungszentrum, Karlsruhe (West Germany)). Jul 1969. 108p. (In German). Dep. CFSTI (U. S. Sales Only).

A control experiment was set up at the EUROCHEMIC reprocessing plant at Mol in order to apply the theoretical results of a systematic analysis of the reprocessing and to test the functioning of newly developed instruments and measurement methods. The aims of the control experiment were to plot a Pu balance independent of operator data and to compare it with the balance of the operators, to select only a small number of strategic points for control studies, to obtain defined initial and final conditions by extreme cleaning of the installation, to make error analyses of the instrumentation and chemical analysis methods used, to compile the practical results in order to design a future monitoring system in reprocessing plants, and evaluate the results by a computer program, and to determine the significance of strategic points with respect to expenditure and data obtained in order to establish priorities for the development of future measurement and analysis methods. The 1747 fuel elements with Al structural material processed during this control experiment contained 759 kg U in the form of UO_2 with 4 different enrichments of 0.7, 1.5, 4, and 4.5%, and 1179 gr of Pu. The average burnup was 10,000 Mwd/t and the cooling time was between 400 and 1200 days. The installation and the establishment of the strategic points are described. The preliminary steps taken before the control experiment are described in detail. The results of the control experiment showed that an independent Pu balance could be established in which only data were used that were produced at the strategic points selected. A comparison of the operator balance and the independently established inspector balance indicated systematic errors. By extreme cleaning before and after the control experiment almost zero conditions could be produced in the material balance zone. The measurement accuracy of the mass or volume measurements by the spray nozzle method are sufficiently accurate in combination with a good calibration. Systematic errors in the chemical analysis could not be avoided in spite of careful adjustments. The costs of the chemical analyses are decisive for the control expenditure. Long sample transportation times and the relatively large time for the isotopic dilution analysis led to large time distortions in the establishment of an independent balance and neglected the advantage of fast data processing by computer programs. The monitoring of fission product flow 24

hrs a day meant too large a burden on the control personnel and should be reduced to the normal work period, which can be done partially by installation of automatic write-outs at some strategic points. (J.S.R.)

20850 (MLM-1721) SOLVENT EXTRACTION OF POLONIUM INTO THE ORGANIC PHASE FOR ANALYTICAL APPLICATIONS: A REVIEW. Bishop, C. T. (Mound Lab., Miamisburg, Ohio). 20 Mar 1970. Contract AT(33-1)-Gen-53. 13p. Dep. CFSTI.

Separation of polonium by solvent extraction into an organic phase is reviewed. Data on 32 extraction systems including phosphates, amines, chelating agents, ethers, ketones and alcohols are summarized in tabular form. The composition of the aqueous and organic phases, the elements extracted into the organic phase and those remaining in the aqueous phase, and references are given. Distribution ratios or percentage extraction data are also given where these quantities were determined. (44 references). (auth)

20851 (NACAR-10004) KRYPTON-XENON ADSORPTION ON NACAR CARBONS. Kovach, J. Louis (North American Carbon, Inc., Columbus, Ohio. Research and Development Dept.). 28 Dec 1969. 17p.

Krypton and xenon adsorption isotherms and isobars are presented for two groups of activated coconut carbons. The adsorption isotherms were determined at equilibrium conditions. The adsorption isobars were derived from the adsorption isotherm curves. (auth)

20852 (NP-18166) IODINE SEPARATION FROM THE PROCESS OFF-GAS OF A REPROCESSING PLANT. Literature Review. Roth, B. F.; Beutner, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Jun 1969. 69p. (In German). Dep. CFSTI (U. S. Sales Only).

Separation methods for iodine vapor include: use of metallic filters, silver reactors, activated carbon filters, adsorption in water, ion exchange, sorption by silver-coated silica gel, and molecular sieves. Methods for removing organic iodine compounds and iodine aerosols are also considered. (M.C.G.)

20853 (NUMEC-3292-11) THE RECOVERY OF ^{10}B FROM LOW CONCENTRATION WASTES. Shuster, E. R.; Pepkowitz, L. P.; Marano, R. T.; McGahan, J. F.; Bodnick, Paul (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). 12 Dec 1969. Contract AT(40-1)-3292. 18p. Dep. CFSTI.

A general-purpose quantitative chemical process for reclamation of boron-10 from a variety of process wastes and side streams is described. The process consists of selective pretreatment of various scrap types, a single boron-10 separation procedure using an ion exchanger, and a crystallization process yielding high-purity boric acid crystals. Extensive demonstration of the process on a pilot scale as applied to the recovery of boron-10 from KCl-KF spent electrolyte was included. Preliminary scale-up information shows a realistic expectation of at least 98% recovery. (auth)

20854 (ORNL-tr-2292) REMOVAL OF CONDENSED PHOSPHATES FROM RADIOACTIVE WASTES. Drobnik, S.; Kluger, W.; Hepp, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report KFK-917. 24p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 264.

20855 SEPARATION OF THE NEON ISOTOPES BY CRYOGENIC CHROMATOGRAPHY. Purer, A.; Kaplan, R. L.; Smith, D. R. (Bureau of Mines, Amarillo, Tex.). J. Chromatog. Sci.; 7: 504-7(Aug 1969).

A gas chromatographic system for the separation of the Ne isotopes at column temperatures of 15 to 25°K is described. Hydrogen was used as a deactivating gas mixed with the He carrier gas to eliminate absorption of small Ne samples and the columns. The high resolution obtained for the separation of ^{20}Ne and ^{22}Ne indicates that it should also be possible to separate ^{21}Ne. A 5% H 95% He mix offered a workable compromise between retention time and peak shape. By using this mixture through a series of sample-size reductions, the separation of ^{20}Ne and ^{22}Ne was achieved. The best separation occurred in the 18° to 19°K range. The ^{20}Ne was eluted first with the best separation occurring near the middle of the temperature range. At temperatures approaching 15°K, separation was lost. The separation factor for the Ne isotopes reached a maximum in the 18 to 19°K temperature range and remained high until about 25°K was reached. In the vicinity of 27°K, separation quickly decreased to unity. (BBB)

20856 SOLVENT EXTRACTION AND SEPARATION OF SOME LANTHANIDES AND AMERICIUM BY EXTRACTION CHROMATOGRAPHY IN THE SYSTEM ALIQUAT-336-$LiNO_3$ AND HNO_3. Stronski, I. (Inst. of Nuclear Physics, Krakow). Chromatographia, 2: 285-8(1969).

The liquid-liquid extraction of Nd, Eu, Ho, and Am nitrates was studied by means of the radiotracer method in the system tri-caprylmonomethylammonium nitrate(Aliquat-336)-lithium nitrate and nitric acid. A mixture of tracer quantities of Eu-Am, Nd-Pr, Sm-Pm, Gd-Eu, Er-Ho, Tm-Er, Yb-Tm, and Lu-Tm was separated by column partition chromatography. It was confirmed that all tervalent lanthanides and Am may be extracted from concentrated solutions of $LiNO_3$ in dilute HNO_3 at pH = 2 to 4. The dependence of the yield of extraction of Ho nitrate from 8M $LiNO_3$ solutions in the range 1×10^{-4} to 4N HNO_3 on the HNO_3 concentration showed that at pH 2 to 4 the yield of the extraction is very high but decreases with an increase in the HNO_3 concentration. The distribution coefficient D for the Nd, Eu, Ho, and Am nitrates was dependent on the concentration of Aliquat-336, as well as on the concentration of lithium nitrate. Owing to the fact that Am, as well as the other transplutonium elements, forms more stable complexes than the lanthanides, rare earths can be comparatively easily separated from the tervalent actinides. The chromatogram of separation of Eu and its homolog Am, after washing the column with 4.2M $LiNO_3$, is shown. By changing the concentration of $LiNO_3$ various pairs of rare earth elements ions could be separated by extraction chromatography. (BBB)

20857 EXTRACTION OF Mo(VI) AND Re(VII) FROM MINERAL ACID SOLUTIONS BY TERTIARY AMINES. Anokhina, L. G.; Agrinskaya, N. A.; Petrashen, V. I. Zh. Neorg. Khim.; 15: 155-60(Jan 1970). (In Russian).

Studies were made on the extraction of Mo(VI) and Re(VII) from HNO_3, H_2SO_4, and HCl solutions by toluene solutions of N-methyldioctylamine and trioctylamine. The relation of the degree of extraction on the concentration of acids was found and established the effects of the nature of the competing anions on the extraction ability of the amines. (tr-auth)

20858 SELECTIVE EXTRACTION OF INORGANIC IONS BY MEANS OF CHELATING SURFACE ACTIVE AGENTS. NOTE II: THE BEHAVIOUR OF THE ALKALI EARTH METALS. di Lello, Maria Cristina; Turi, Carla Jacobelli; Margani, Alessandro; Palmera, Mario (Univ., Rome). Ric. Sci.; 39: 264-6(Mar 1969).

The foam extraction behavior of Zn^{2+}, Ca^{2+}, Ba^{2+}, and Sr^{2+} using the chelating surfactant dodecyliminodipropionic acid was studied. (M.C.G.)

20859 EXTRACTION OF RARE EARTH METALS BY TETRAOCTYLMETHYLENEDIPHOSPHINE DIOXIDE. Suvorovskaya, N. A.; Kuznetsova, Yu. S. Izv. Akad. Nauk SSSR, Metal.; No. 1, 88-90(Jan-Feb 1970). (In Russian).

The extraction of yttrium and samarium from dilute solutions of nitric acid and ammonium nitrate by methylenebis[bis(2-ethylhexyl) phosphine oxide in kerosene proved to be more efficient than trioctylphosphine oxide. The process can be used for raw materials with small rare earth metal content. (tr-auth)

20860 OPTIMISING DECISIONS IN THE OXIDE FUEL PROCESSING CYCLE FOR NUCLEAR POWER GENERATION. Steele, Gordon E. (United Kingdom Atomic Energy Authority, Capenhurst, Eng.). J. Syst. Eng.; 1: 71-89(Autumn 1969).

Problems concerning the optimum installation of facilities to meet the future demand for the supply and reprocessing of oxide fuel, and the operation of these facilities so that the whole complex operates at optimum efficiency are discussed. Mathematical models of the various facilities have been constructed and are being integrated into an overall model of the out-of-pile fuel cycle. With the aid of a computer, this model is being used to assess the economic consequences of various capital investment decisions and to control flows of material in the cycle during actual operations. The mathematical model is described and examples of its use are given. (J.G.B.)

20861 TEMPERATURE EFFECT ON THE EXTRACTION OF LANTHANIDES IN THE TBP-HNO_3 SYSTEM. Fidelis, I. (Inst. of Nuclear Research, Warsaw). J. Inorg. Nucl. Chem.; 32: 997-1003(Mar 1970).

Measurements were made of the extraction coefficients of the lanthanides by TBP at 10, 17, 25, and 40°C. From these results the separation factors, the enthalpy, relative free energy and entropy changes associated with the extraction process were calculated. All separation factors obtained showed the regularities which were found using 2-ethylhexyl phenylphosphonate as an extractant. Lanthanides examined were La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu. (auth) (UK)

20862 PLUTONIUM PROCESSING CHAIN: GENERAL DESCRIPTION. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 79-80, 43-5(Sep-Dec 1969). (In French).

The production of Pu metal by calciothermy starting with PuF_4 is the last operation in the cycle for the recovery of metallic Pu.

Plutonium is produced by heat under vacuum in a mixture of PuF_4 and Ca: the PuF_4 is reduced by Ca and it forms a fusible slag, which rises to the surface and leaves at the bottom the metallic ingot which is then collected after solidification and cooling. The operations are automatic. (P.C.H.)

20863 PARTITION OF OXIDIZED AMERICIUM FROM ACTINIDES(III) AND LANTHANIDES(III). Mason, G. W.; Bollmeier, A. F.; Peppard, D. F. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 32: 1011-22(Mar 1970).

In the liquid–liquid extraction system 0.6 F bis(2,6-dimethyl-4-heptyl) phosphate, indexed as bis(1-isobutylisopentyl) phosphate (HD(DIBM)P) in n-heptane vs an aqueous 0.025 F HNO_3 + 0.025 F $AgNO_3$ + 0.185 F $K_2S_2O_8$ phase K for oxidized Am, presumably Am(VI), was greater than 40 while that for Cm(III) was less than 1×10^{-5}; and the K values for each M(III) actinide and lanthanide tested were always less than 1×10^{-3}. Consequently, this system may be used for the purification of americium with respect to M(III) actinides and lanthanides or, alternatively for the purification of M(III) actinides and lanthanides with respect to americium. Details of the mutual separation of ^{241}Am and ^{244}Cm through the application of this liquid–liquid extraction system are given. Proposed extension of the study to extraction chromatography employing HD(DIBM)P as the stationary phase is discussed. (auth) (UK)

20864 TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES BY CLAYEY MINERALS. Matsumura, Takashi (Osaka Prefectural Radiation Center, Sakai, Japan). Nendo Kagaku; 9: No. 1-2, 1-9(Nov 1969). (In Japanese).

The cost and availability of clay-type minerals, in addition to their ion exchange properties and radiation resistance, make them suitable for disposal of liquid radioactive wastes. Condensation–precipitation and ion exchange of low-level liquid wastes and solidification of high-level wastes are suitable fixation processes for use with clay-type minerals. The following specific applications are described: treatment and disposal of radioactive waste water by clay-type minerals, selective adsorption of ^{137}Cs on clays, fixation of ^{137}Cs in clays, adsorption of ^{137}Cs on zeolite, adsorption of radioactive Sr, and adsorption of ^{106}Ru and ^{60}Co. (NSA of Japan)

20865 PRODUCTION OF ^{237}U. Suzuki, Susumu; Sato, Akiko (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 85-8(1968). (In Japanese).

The solvent extraction behavior of uranium was studied with ^{237}U as the tracer. The U(III) was obtained by reducing U(VI) containing ^{237}U in HCl solution with Zn amalgam in an inert gas atmosphere. Di-n-butyl phosphate in benzene solution was used as the organic phase. After equilibration, the activity of each phase was measured by a well-type scintillation counter. The solvent-extraction behavior of U(III) with DBP was found to be the same as that for trivalent transuranic elements and rare earths. The reaction was considered to be as $U^{3+} + 3(HDBP)_2 \rightleftharpoons U[H(DBP)_2]_3 + 3H^+$. (NSA of Japan)

20866 METODOLOGIE ANALITICHE ED EQUILIBRI IN SOLUZIONE. Convegno Tenuto a Roma, 12–14 Gennaio 1967. (Analytic Methodology and Equilibrium in Solution. Conference Held at Rome, January 12–14, 1967). Corsi e Seminari di Chimica, No. 9. Roma; Consiglio Nazionale delle Ricerche (1968). 172p. (CONF-670126,.

Forty-one papers are included; separate abstracts were prepared for five. The remaining papers contain information on the general problems and analytical methodology of equilibrium in solution, electroanalytical methods of analysis, methods of distribution between phases, equilibria in solution, and applied analytical methodology. (J.S.R.)

For abstracts of individual papers see: 20780, 20781, and 20867–20869.

20867 DETERMINATION OF ISOTOPES BY GAS CHROMATOGRAPHY. Cartoni, Giampaolo (Univ., Naples. CNR, Naples). pp 51-2 of Metodologie Analitiche ed Equilibri in Soluzione. Roma; Consiglio Nazionale delle Ricerche (1968). (In Italian).

From Conference on Analytic Methodology and Equilibrium in Solution, Rome, Italy. See CONF-670126.

The problems involved in the separation of isotopic molecules by means of chromatography in the gaseous phase were studied on numerous normal and deutero-substituted hydrocarbon systems. These studies indicate that only in some cases the values of the activity coefficients measured experimentally are in good agreement with those calculated attributing the isotopic effect to the difference of the molecular volume. Studies on methane in which the hydrogen isotopes were partially or completely substituted with deuterium showed the existence of a linear relation between the logarithms of the relative retention volumes and the ratio of the mass of the various substituted methanes. A capillary column was used to separate the oxygen isotopes $^{16}O_2$ and $^{18}O_2$. From a theoretical treatment of the problem of isotopic separation it was shown how it was possible to predict the number of theoretical plates which a chromatographic column should have in order to obtain a predetermined separation, and the validity of the study was experimentally tested on a series of systems such as CH_4-CD_4, $C_2H_6-C_2D_6$, and $C_2H_4-C_2D_4$. (J.S.R.)

20868 CHEMISTRY OF $RuNO^{3+}$ COMPLEXES. Morpurgo, Laura (Univ., Rome. CNR, Rome). pp 113-15 of Metodologie Analitiche ed Equilibri in Soluzione. Roma; Consiglio Nazionale delle Ricerche (1968). (In Italian).

From Conference on Analytic Methodology and Equilibrium in Solution, Rome, Italy. See CONF-670126.

A chromatographic method was developed for the characterization, separation, and determination of the various nitrate–water–nitrosyl–ruthenium complexes. The separation of $RuNO^{3+}$ from other fission products and the decomposition of the nitrosyl ruthenium group are also discussed. (J.S.R.)

20869 THIN LAYER CHROMATOGRAPHIC SEPARATION OF RADIONUCLIDES. Bottura, Giorgio; Breccia, Alberto (Univ., Bologna. CNR, Bologna). pp 144-50 of Metodologie Analitiche ed Equilibri in Soluzione. Roma; Consiglio Nazionale delle Ricerche (1968). (In Italian).

From Conference on Analytic Methodology and Equilibrium in Solution, Rome, Italy. See CONF-670126.

The principle of the thin-layer chromatographic method for the separation of radionuclides is described. The results obtained in the experimental application of this method to the separation of radionuclides from their immediate decay products, to the separation of mixtures of decay products, and to the separation of trace elements in inorganic matrices are presented. The systems studied were $^{90}Sr-^{90}Y$, $^{95}Zr-^{95}Nb$, $^{140}Ba-^{140}La$, $^{113}Sn-^{113}In$, artificial mixtures of fission products, mixtures of irradiated fuels, and the separation of traces of Mn in Al and of Hg in Ag. The results showed that the thin-layer chromatographic method gives fast and complete separations in complex mixtures. (J.S.R.)

20870 SEPARATION OF ZIRCONIUM BY THIN-LAYER CHROMATOGRAPHY. Kojima, Masuo; Oguma, Koichi Tokyo Kogyo Shikensho Hokoku; 65: 28-32(Jan 1970). (In Japanese).

The thin-layer chromatographic separation of a number of metal ions, Sc, Y, Zr, La, Sm, Th, U(VI), etc., with solvent mixtures of mesityl oxide, ethanol, and 5 M HNO_3 on silica gel–cellulose (5 : 1) thin-layer plates is reported. Zirconium remains stationary while the other metal ions move with the solvent, thus allowing a selective separation of zirconium from about 20 metal ions in ratios ranging from 100 : 1 to 1 : 100. Mixtures of various metal ions can also be separated. (auth)

20871 THE SOLVENT EXTRACTION OF METAL IONS FROM SULFURIC ACID SOLUTIONS WITH A MIXED EXTRACTANT: LONG-CHAIN PRIMARY AMINE AND DI-2-ETHYLHEXYLPHOSPHORIC ACID. Watanabe, Hiroto (Muroran Inst. of Tech., Hokkaido, Japan). Bull. Chem. Soc. Jap.; 43: 100-4(Jan 1970).

The distribution of metal ions between phases of dilute H_2SO_4 and CCl_4 containing long-chain primary amine (Primene JM) and bis(2-ethylhexyl) phosphatic (D2EHPA) was investigated. The degree of the extraction of bi- and tervalent metal ions, such as Zr, Fe(III), In, La, and Ce(III), was lowest when the organic phase contained 5 g/l of Primene JM and 7 to 8 g/l of D2EHPA, while a minimum extraction of Th occurred at a different composition of the organic phase. Thus, Th can be quantitatively separated from most other metals by extraction from a 0.1 N H_2SO_4 medium with CCl_4 containing 5 g/l of Primene JM and 7 to 8 g/l of D2EHPA. Under these extraction conditions, a single extraction is sufficient for the quantitative separation of Th from high concentrations of lanthanide metals. Contrary to the usual method of extraction using long-chain amines, which involves a tedious multiple extraction, the mixed-extractant technique described is simple and will find many uses in the determinations of Th in a variety of samples. (auth)

20872 METHOD OF TREATING IRRADIATED NUCLEAR FUEL. (to Fried, Krupp Gesellschaft mit Beschraenkter Haftung). British Patent 1,185,098. 18 Mar 1970. Priority date 7 Sep 1966, Germany.

A method is described for reprocessing irradiated fuels consisting of the oxide or carbide of Th or U coated with a layer of pyrolitic graphite and embedded in a matrix of graphite. The fuel element is heated to a temperature in the range of 2500 to 3000°C to form a eutectic from the graphite, the nuclear fuel, and the non-volatile decomposition products and to vaporize the volatile decomposition products. The radioactive substances in the eutectic are then converted into volatile compounds by halogenation and are separated from the other components of the eutectic. (B.L.M.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 20706, 20847, 20891–20893, 20927, 20932, 20969, and 21148.

20873 (BNWL–1299) POTENTIAL THERMAL EFFECTS OF AN EXPANDING POWER INDUSTRY: OHIO RIVER BASIN. [PART] I. Peterson, D. E.; Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 79p. Dep. CFSTI.

Simulations of 1964 daily average stream temperatures of the Ohio River System were performed using the COLHEAT computer code. Average monthly direct cooling capacities of the Ohio River and its major tributaries (excluding the Cumberland and Tennessee Rivers) within a 5°F envelope were calculated and found to range between 261,000 and 95,000 MW_T. Projected steam-electric loads and cooling facility trends for the Ohio Basin indicate that direct cooling water requirements will equal low monthly average direct cooling capacity by the year 1990. Ancillary cooling facilities for low flow periods could extend the use of direct cooling for a major part of the cooling requirements through the turn of the century. (auth)

20874 (ORO–490–19) RADIOACTIVITY TRANSPORT IN WATER: MATHEMATICAL SIMULATION. White, Allen; Gloyna, Earnest F. (Texas Univ., Austin. Center for Research in Water Resources). [1969]. Contract AT(11-1)-490. 37p. (EHE–70-4; CRWR–52). Dep. CFSTI.

A mathematical model has been developed for routing a radionuclide through a model river system. The capabilities of this simulation model include the following characteristics: it distributes radionuclide activity by advective and dispersional mechanisms along the longitudinal axis of the system; it may be discretized into any number of segments (vertical planes normal to the longitudinal axis) as may be appropriate to describe spatial variations in radionuclide activity; it is capable of treating instantaneous, continuous, or time-varying releases of radionuclide activity; it provides for a temporal description of radionuclide activity throughout the system; and it provides for sorption and desorption by both plants and bottom sediments. (auth)

20875 (ORO–490–20) RADIOACTIVITY TRANSPORT IN WATER: SUMMARY REPORT. Yousef, Yousef A.; Kudo, Akira; Gloyna, Earnest F. (Texas Univ., Austin. Center for Research in Water Resources). Feb 1970. Contract AT(11-1)-490. 80p. (EHE–70-5; CRWR–53). Dep. CFSTI.

A transport model is presented which describes the behavior of radionuclide movement in an ecological system, and considers hydraulic transport, sediment sorption and desorption, and biomass uptake and release. Solutions of the transport model are programmed and verified using data obtained from the laboratory ecosystem and the research flume. The limitations and relative importance of environmental factors affecting transport were evaluated. Recommendations for the use of this prediction model are discussed. Flume experiments limited to fresh water systems and slow-moving streams were conducted. In general, radionuclide movement followed the same pattern as Rhodamine B dye releases. However, discrepancies were observed due to interactions of radionuclides with sediments, biomass and organic debris. Therefore, before tests were conducted in the fully instrumented flume (model river), laboratory experiments with small ecosystems (aquaria) were conducted to help evaluate the functional form and factors involved in prediction models. The effects of specific environmental factors such as pH, temperature, dissolved oxygen, oxidation-reduction potential of sunlight were studied to estimate the uptake and release rates of radionuclides. The radionuclides investigated included ^{65}Zn, ^{58}Co, ^{103}Ru, ^{137}Cs, ^{85}Sr, and ^{51}Cr. (auth)

20876 (SAN–676–1) SNOW-WATER CONSERVATION. PART I. MIGRATION OF EVAPORATION SUPPRESSANTS APPLIED TO SNOW. Essington, E. H.; Forslow, E. J.; Tuttle, J. D. (Isotopes, Inc., Palo Alto, Calif.). Dec 1967. Contract AT(04-3)-676. 90p. Dep. CFSTI.

The chemicals, hexadecanol and octadecanol, have been shown in previous studies by the U. S. Forest Service to be effective moisture evaporation suppressants when applied to snow-pack surfaces. Laboratory and field studies were conducted to trace the movement of hexadecanol or octadecanol on and through the snow pack to determine if the chemical migrated or remained in place through snow falls and snow melt occurring after application of the chemical. Results of the studies show that: hexadecanol or octadecanol does remain essentially in place, that is, it does not migrate, to any extent through the snow pack if applied in the recommended fashion; hexadecanol or octadecanol is not leached when melt water from added snow percolates through the zone of application; hexadecanol or octadecanol is deposited on the soil surface underlying the treated snow pack, after the snow is melted (the chemicals do not penetrate the soil profile below one-half inch); and carbon-14 provides a reliable radioisotope label for tracing hexadecanol/octadecanol on and in snow packs, and can effectively be used in field or laboratory studies. (auth)

20877 (SAN–676–2) SNOW-WATER CONSERVATION. PART II. DEVELOPMENT OF RADIOACTIVE TRACER METHODOLOGY TO STUDY GROUND WATER MOVEMENT IN SIERRA NEVADA MOUNTAIN SOILS. Essington, E. H.; Zorich, T. M.; Forslow, E. J.; Tuttle, J. D. (Isotopes, Inc., Palo Alto, Calif.). Dec 1967. Contract AT(04-3)-676. 83p. Dep. CFSTI.

A methodology was formulated and tested to determine water movement velocities and direction in Sierra Nevada mountain soils. A complete methodology is presented incorporating discussions of tracer choice, compatibility, requirements assuring health and safety in use of radioactive tracers, and descriptions of laboratory and field experiments. Certain procedures were tested and a group of candidate radioactive tracers were identified. The procedures were tested with specific soil-water-tracer combinations. A list of tracer distribution coefficients and flow rates through several mountain soils is presented. Water flow velocities in both saturated and less than saturated soil moisture conditions at the Onion Creek Experimental Forest water tracer plot were determined. Scandium-46–CDTA (trans-1, 2-cyclohexane diaminetetraacetic acid), as a water tracer, indicated a saturated flow velocity of 9.7 feet per 24 hours. Tritiated water, as a water tracer, revealed only a slight downward migration of water in less than saturated soil moisture conditions. With this information, interested users can install soil water tracing systems for both saturated and less than saturated soil moisture conditions and can choose a desirable water tracer or combination of tracers to suit their needs. Information obtained from water tracer studies of this type will enable timber and water managers to better determine the fate of water deposited on mountain watersheds. (auth)

20878 (UCRL–72152) BEHAVIOR OF RADIONUCLIDES IN NUCLEAR GAS STIMULATION TECHNIQUES. Smith, C. F. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). 21 Dec 1969. 15p. (PNE-G-56; CONF-700101-15). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

The Gasbuggy experiment has presented a unique opportunity to investigate the behavior of radionuclides over an extended period of time in a somewhat unusual environment. In addition to the obvious practical utility of this investigation for Plowshare applications, the information gained has value of a purely scientific nature. Both aspects of the Gas Quality program for Gasbuggy are discussed. The study of Gasbuggy results is divided into two distinct periods, according to the field operations. During the initial six months following detonation, the chimney reentry well was shut-in, and the nuclear chimney served as a chemical and radiochemical reaction vessel. A detailed examination of the concentrations and specific activities of tritium and ^{14}C is presented as a function of the changing chemical composition of the chimney gas and as a function of time. The effects of radiochemical exchange reactions, together with the tritium isotope effect, are demonstrated. Following this shut-in period, a series of production and flushing tests was conducted. During these experiments, the chimney gas composition was seen to change about as would be expected due to dilution of the chimney gas with formation gas. An examination of radionuclide concentrations and specific activities during the production tests demonstrated the relative unimportance of isotopic exchange and chemical reactions during this period, as compared to the early shut-in periods. Within the limitations of the Gasbuggy experience a generalized model of the behavior of tritium and ^{14}C can be deduced. The discussion involves estimation of initial distribution of activities, the effects of chemical reactions and isotopic exchange on this distribution, and the importance of the environment in determining the level of radioactivity contamination to be expected. (auth)

20879 (USGS–474–71) GEOLOGIC AND HYDROLOGIC EFFECTS OF THE MILROW EVENT, AMCHITKA ISLAND, ALEUTIAN ISLANDS, ALASKA. Amchitka-20. (Geological Survey, Denver, Colo.). 1970. Contract AT(29-2)-474. 76p. Dep. CFSTI.

A program was conducted to determine the geologic and hydrologic effects of the Milrow event, an underground nuclear explosion of about 1 megaton which was fired at Amchitka Island on October 2, 1969. Preliminary factual data are given on geologic effects (faults, rockfalls, slumps, soil disturbances, and landslides), ground displacement measurements including strain and tilt determinations, in-situ rock stress determinations made before and after the event, effects on the surface and subsurface hydrologic regime, and marine geophysical effects (faults on the ocean floor). Analysis of much of this data is incomplete. (L.C.L.)

20880 FISSION TRACK AGES OF YOUNGER INTRUSIONS IN SOUTHERN MAINE. Christopher, Peter A. (Univ. of British Columbia, Vancouver). Geol. Soc. Amer., Bull.; 80: 1809-13 (Sep 1969).

Fission track ages were obtained for 10 apatite concentrates from 6 post-Paleozoic stocks in southern Maine in order to check the reliability of the fission track method in post-Paleozoic terrains, establish an age for the youngest igneous event in the area, and check the geologic correlation of the Burn Meadow Complex and the Agamenticus Complex with the White Mountain plutonic-volcanic series. The procedure for determining fission track ages involves determining the spontaneous fission track density on an etched interior surface of a mineral, using the calculated value for λ_F, and determining the ^{238}U content. An accurate, indirect determination of the ^{238}U content can be made by exposing an annealed portion of the sample to a known dose of thermal neutrons. The fission-track data were compared with other dating results, and then discussed in relation to the other results. The low-annealing temperature for fission tracks in apatite is reflected by several sets of data. (BBB)

20881 HUNGARIAN RESEARCH IN THE FIELD OF ISOTOPIC GEOCHEMISTRY. Kovach, Adam (Nuclear Research Inst., Budapest). Atomtech. Tajek.; 12: 251-4(1969). (In Hungarian).

The temperature of formation of geological compounds was determined on the basis of the $^{18}O/^{16}O$ ratio. The studies revealed that the ore seam at Parádsasvár was initially formed at 400°C; this was followed by a strong temperature drop to 150°C, at which temperature most of the seam was formed. Similar conditions of the travertine tuffaceous limestone at Tata were studied by determining the $^{18}O/^{16}O$ ratio of the carbonates. It was found that the recrystallization temperature increased strongly with the depth, with a maximum difference of 118°C for a drilling depth of 77 m. High-precision density measurements of water samples from deep wells revealed differences in the combined shifts of the isotopic composition of hydrogen and oxygen. Measurement of the isotopic composition of carbon, determined in natural gas samples led to the conclusion that the CO_2 found in mixture with hydrocarbons originated from the basement carbonate rocks. Formation of the Mecsek uranium ores was investigated by determining the isotopic ratio of sulfur in the sulfides. The results point toward a sedimentary nature of the ores. Magnetic problems of igneous rocks were studied by determining the Rb/Sr ratio. The results support the recently developed volcanic concept of the inner Carpathian rim. Measurement of the K/Ar and Rb/Sr ratios was used for age estimation of rocks in various parts of Hungary. (19 references.) (TTT)

20882 $^{40}Ar/^{39}Ar$ AGE DETERMINATIONS ON NEPHELINE AND BASIC WHOLE ROCKS. York, D.; Berger, G. W. (Univ. of Toronto). Earth Planet. Sci. Lett.; 7: 333-6(Jan 1970).

One biotite, one nepheline, and two samples of basic dikes were irradiated in a nuclear reactor and $^{40}Ar/^{39}Ar$ ages were calculated. These ages agreed well with conventional K–Ar ages on the same materials, differing at most by 3.5%. (auth)

20883 DEUTERIUM CONTENT OF ORGANIC MATTER. Schiegl, W. E.; Vogel, J. C. (Council for Scientific and Industrial Research, Pretoria). Earth Planet. Sci. Lett.; 7: 307-13 (Jan 1970).

The natural deuterium content of organically bound hydrogen showed systematic variations that depended on the origin of the samples. The hydrogen of both marine and land plants contained several percent less deuterium than the water on which the plants grew. Coal and oil were further depleted in deuterium with respect to plants, and natural gas was still more depleted in deuterium with respect to the coal or oil from which it is derived. (auth)

20884 ISOTOPIC COMPOSITION AND ORIGIN OF THE ATMOSPHERIC WATER VAPOR IN THE REGION OF LAKE GENEVA. Fontes, J.-Ch. (Faculte des Sciences, Paris); Gonfiantini, R. Earth Planet. Sci. Lett.; 7: 325-9(Jan 1970). (In French).

The isotopic composition of the atmospheric water vapor over Lake Geneva changed regularly with the distance from the water surface. This fact indicates that the vapor results from a mixing of the vapor generated by the lake with the regional atmospheric vapor. The fractions of these two vapors of different origin are evaluated in each sample on the basis of the isotopic data. The method allows an estimation of the climatic zone of influence of the lake in the atmosphere to be made. (auth)

20885 MEASURING UNDERGROUND-EXPLOSION EFFECTS ON WATER LEVELS IN SURROUNDING AQUIFERS. Garber, M. S.; Wollitz, L. E. (Geological Survey, Denver). Ground Water; 7: No. 4, 5(Jul-aug 1969).

Underground detonations may produce observable effects in surrounding aquifers and wells. The nature and the duration of the effect at any observation point seem to depend on several factors such as the amount of energy released by the detonation, the geologic environment, the position of the buried explosive device in relation to the saturated zone, aquifer characteristics, and the distance from point of detonation. Precise measurement of these effects in wells presented numerous technical problems and resulted in the development of specialized techniques. Initially, these effects were observed by measuring the fluctuation of the free water surface in wells. The current technique employs high-resolution pressure transducers deep in the water column. Pneumatic packers may be used to restrict the movement of water into the well. Data are recorded on high-speed oscillographs. (auth)

20886 SEARCH FOR TRANSURANIUM ELEMENTS IN IRON–MANGANESE NODULES. Otgonsuren, O.; Perelygin, V. P.; Flerov, G. N. (Joint Inst. of Nuclear Studies, Dubna, USSR). Dokl. Akad. Nauk SSSR; 189: 1200-3(21 Dec 1969). (In Russian).

Iron–manganese nodules have a number of advantages compared to other sources in the search for superheavy elements. The nodules are selective absorbents of a number of heavy elements such as Pb, Tl, Hg, and W with enrichment coefficients of 10^5 to 10^6 as compared to ocean water. The age of the nodules varies from a few hundred thousand to millions of years. The heavy element content in the nodule is protected from fission by cosmic rays. Nodule inclusions of organic and mineral origin can serve as fission product detectors in principle. Nodules collected from the bottom of the South Pacific Ocean were examined for fission product tracks under a microscope after etching with hydrofluoric acid. The observed track density was greater than could be accounted for by the uranium content and age of the nodules estimated by various methods. This difference could be due to the absorption of heavy elements, but the evidence is not conclusive. (TTT)

20887 CROSS-CHECKING OF FISSION TRACK METHOD AND K–A METHOD FOR AGE DATING. 2. ON THE VOLCANIC ROCKS. Shima, Makoto; Yabuki, Sadayo (Inst. of Physical and Chemical Research, Saitama, Japan). Ganseki Kobutsu Kosho Gakkaishi; 62: 299-303(Nov 1969). (In Japanese).

Some volcanic rocks have been dated by fission track and K–Ar methods. The measured ages for the basalt from Kita-Kyushu agreed well with each other. However, on the basalt of Nemuro, Hokkaido, a large discrepancy was found between the results of these two methods. (auth)

20888 FISSION-TRACK AGES OF ACCESSORY MINERALS FROM GRANITIC ROCKS OF THE CENTRAL SIERRA NEVADA BATHOLITH, CALIFORNIA. Naeser, C. W.; Dodge, F. C. W. (Geological Survey, Menlo Park, Calif.). Geol. Soc. Amer., Bull.; 80: 2201-12(Nov 1969).

A fission track method is described which was used to determine ages of apatite, sphene, allanite, epidote, and garnet from plutonic rocks of the central Sierra Nevada and Inyo Mountains. The fission-track etching conditions are listed in a table. Because of its homogeneous U distribution, apatite was not treated in the same way as the other minerals. The second group of minerals was wrapped in aluminum foil and heated to 600°C for several hours to anneal and remove fossil tracks. After annealing, this package was exposed in a reactor for neutron irradiation. Following irradiation, the annealed apatite was mounted, polished, and etched. The tracks in this sample, which were all produced in the reactor, were counted to determine the induced track density. Minerals other than apatite could not be treated in this manner because of the heterogeneity of the U distribution between grains of the same separate. Grains were mounted in a thick epoxy wafer, and polished and etched to develop fossil tracks. The wafer was then washed, taped to a plate of muscovite, and irradiated. Induced fission tracks were thus recorded in the muscovite. A glass slide with a known content of U was inserted in each reactor package. The equivalent neutron flux was determined by counting induced tracks in the slide. Results of fission-track age determinations for accessory minerals are given in a table. Ages ranged from 54 to 140 Myr. They were determined on 44 apatites, 34 sphenes, 3 epidotes, 2 allanites, and 1 garnet. (BBB)

Meteorology

Refer also to abstracts 21148 and 21149.

20889 (A-AC-82/G/L-1276) RADIOACTIVE FALLOUT AFTER THE NUCLEAR EXPLOSIONS IN POLYNESIA, 1967 AND 1968. (France). 12 May 1969. 121p. (In French). Dep. CFSTI (U. S. Sales Only).

Sampling done after the 1967 and 1968 nuclear tests was made in France itself or in its overseas territories, in countries where France has military bases, and in countries with which a bilateral cooperation had been established—Chili, Colombia, Equador, and Peru. The results obtained for both years are presented, discussed, and interpreted separately according to the following plan. First the methods of analysis and measurement used are described. The processes of atmospheric and oceanic dispersion of the contamination and their results on the content of food chains and of man, are discussed. The results of the measurements and the health interpretations are given. The results are shown both in tables and graphically. (tr-auth)

20890 (CEA-R-3945) EVALUATION OF DIFFUSION OF GASEOUS EFFLUENTS IN THE FREE ATMOSPHERE FROM A CONTINUOUS POINT SOURCE. GRAPHS AND COMMENTARY. Le Quinio, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1970. 23p. (In French). Dep. CFSTI (U. S. Sales Only).

Simplified graphs are presented which facilitate evaluation of the consequences of fission product release. About two hundred experimental releases concerning ten different sites were used to establish these graphs. The proposed low values and the non-use of fundamental parameters (e.g., wind speed, and temperature gradient) are justified with various references. The influence of the exposure time on the values obtained for the diffusion coefficients is pointed out. (auth) (France)

20891 (PROT.-SAN.-6/68) DATA ON ENVIRONMENTAL RADIOACTIVITY COLLECTED IN ITALY, JANUARY–JUNE 1967. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Mar 1968. 185p. Dep. CFSTI (U. S. Sales Only).

The results of environmental radiation monitoring performed at more than 150 stations throughout Italy during January to July 1967 are presented. Tabulated data on the gross beta radioactivity in ground-level air and deposited on the ground by fallout and rain, the ^{137}Cs and ^{90}Sr content in animal bones, fish, milk, soil, surface water, and vegetables, the ^{137}Cs content in beef, and the ^{90}Sr content in drinkable water are included. (L.C.L.)

20892 (PROT.-SAN.-12/68) DATA ON ENVIRONMENTAL RADIOACTIVITY COLLECTED IN ITALY, JULY–DECEMBER 1967. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Dec 1968. 212p. Dep. CFSTI (U. S. Sales Only).

The results of environmental radiation monitoring performed at more than 150 stations throughout Italy during July through December 1967 are presented. Tabulated data on the gross beta radioactivity in ground-level air and deposited on the ground by fallout and rain, the ^{137}Cs content in beef, the ^{89}Sr content in fallout, milk, and surface waters, the ^{90}Sr content in drinkable water, and the ^{137}Cs and ^{90}Sr content in animal bones, fish, foods, milk, soils, surface waters, vegetables, and wines are included. (L.C.L.)

20893 (WASH-1148) RADIATION SURVEILLANCE NETWORKS. Allen, Robert E. (comp.) (Division of Operational Safety (AEC), Washington, D. C. Nuclear Explosives Environmental Safety Branch). Nov 1969. 140p. Dep. CFSTI.

The facilities and methods used at 25 separate USAEC installations for monitoring environmental radioactivity are described. All installations sampled and monitored air and surface water, and individual installations also monitored atmospheric precipitation, bottom sediments, marine life, milk, soil, vegetation, or wild animals. The origin and operation of the US Public Health Service's pasteurized milk surveillance program are discussed. This monitoring network covers 50 states, the Canal Zone, District of Columbia, and Puerto Rico. The milk radiation monitoring activities of the Canadian government and 12 state governments in the US are described. Facilities in the US for monitoring foods in standard diets are briefly summarized. The air and atmospheric precipitation radiation monitoring programs of Canada, United States, Mexico, and South America are discussed. The Health and Safety Laboratory (HASL) program for monitoring ^{90}Sr fallout in the western hemisphere is presented. Water (surface and drinking) monitoring programs in various US states are described. Two programs for determining the ^{131}I content in bovine thyroids and ^{90}Sr content in human bones are mentioned. (L.C.L.)

20894 INTERHEMISPHERIC MIXING OF FALLOUT DEBRIS IN THE MONSOON REGIONS. Rangarajan, C.; Gopalakrishnan, Smt. S.; Vohra, K. G. (Bhabha Atomic Research Centre, Bombay). J. Geophys. Res.; 75: 1753-9(20 Mar 1970).

Striking evidence for interhemispheric mixing of the air masses in the Indian Ocean region during the period July–September has been obtained from the measurements of airborne radioactivity at a network of stations in India following the French tests in the South Pacific region from 1966 to 1968. This is based on the early detection of tropospheric activity at the sampling stations after the different tests, particularly after the medium-yield tests of 1968. Measurements of ^{137}Cs and ^{95}Zr showed a minimum arrival time of 17 days at the southern stations in India. It is found that the most likely mode of travel for air masses of the southern hemisphere during the period July–September is by way of the summer monsoon in the Indian Ocean region. The importance of this study in understanding the classical Indian monsoon and the associated circulation patterns is also discussed. (auth)

20895 AIRBORNE MEASUREMENTS OF ^{222}Rn DAUGHTER IONS IN THE ATMOSPHERE. Jonassen, Niels (Technical Univ. of Denmark, Lyngby); Wilkening, Marvin H. J. Geophys. Res.; 75: 1745-52(20 Mar 1970).

An ion collector suitable for use aboard an aircraft has been developed for the determination of the concentration of ^{222}Rn daughter ions in the lower atmosphere. A transverse electric field in a concentric-cylinder geometry deposits positively charged daughter ions onto an aluminum foil. At the conclusion of a collection the α activity is measured with an α-scintillation detector. The collector is operated so that all ions having mobilities greater than 0.4×10^{-4} $m^2/v/sec$ are deposited. The operation of the device aboard an aircraft while air samples for ^{222}Rn are collected simultaneously makes possible the determination of the fraction of the total equilibrium value of radon daughter products that exist as small ions in a given environment. Typically, this ratio is of the order of 10% with larger values occurring in the early morning hours before eddy diffusion produces a well-mixed lower atmosphere. Vertical profiles show a decrease in both ^{222}Rn and the daughter product small ions with increasing altitude in a stable atmosphere; these same quantities remain roughly constant with height in a well-mixed atmosphere. (auth)

20896 TRANSFER OF NUCLEAR DEBRIS FROM SOUTHERN TO NORTHERN TROPOSPHERE DURING 1968. Peirson, D. H. (Atomic Energy Research Establishment, Harwell, Eng.); Cambray, R. S.; Hawson, C. L. J. Geophys. Res.; 75: 1760-5(20 Mar 1970).

Debris from the French nuclear explosions at Mururoa (22°S, 140°W) during the period July–September 1968 circulated in the southern hemisphere in the same and adjacent zones of latitude. Traces of the debris have been followed across the equator, into the northern hemisphere at Bombay, Hong Kong, and middle latitudes. The transit times of the early debris from the first explosion, from Mururoa to Pretoria, Aspendale (Melbourne), and Bombay are consistent with the average wind fields in the upper troposphere. In particular, rapid interhemispheric transfer is indicated in the lower troposphere over the Indian Ocean. It is not possible to present a unique explanation, supported by plausible meteorological evidence, of the passage of the debris observed at the more northerly stations. Incursions of southern tropospheric debris into the northern hemisphere are documented. It appears that the transfer is favored at this season in the region of the Indian Ocean and the southwest monsoon. More generally, interhemispheric transfer in the troposphere (including the transfer in reverse direction), could possibly be inferred from the wind fields over this and other regions, according to season. (auth)

20897 SEASONAL VARIATION OF SHORT-LIVED RADON PROGENY, ^{210}Pb AND ^{210}Po, IN GROUND LEVEL AIR IN FINLAND. Mattsson, Rolf (Meteorological Inst., Helsinki). J. Geophys. Res.; 75: 1741-4(20 Mar 1970).

Radon progeny in ground level air shows one maximum in midwinter and one in late summer. A significant minimum in April–May seems to be due to lack of local exhalation and is possibly connected with a high ground water level. The mean ThB concentration shows a spring maximum and then decreases as RaC increases toward autumn. In Helsinki city the RaF/RaC ratio is systematically higher than outside town. (auth)

20898 ^{222}Rn CONCENTRATIONS IN THE CONVECTIVE PATTERNS OF A MOUNTAIN ENVIRONMENT. Wilkening, Marvin H. (New Mexico Inst. of Mining and Tech., Socorro). J. Geophys. Res.; 75: 1733-40(20 Mar 1970).

Radon 222 concentrations have been measured in a mountain environment to learn more about ^{222}Rn distribution and to test its usefulness in the study of certain features of convective cloud systems over a mountain range. Theoretical considerations make the use of ^{222}Rn rather than its daughter products necessary in

tracer applications of this kind. When the atmosphere is in a quiescent state, as generally occurs in the early morning hours, aircraft sampling gives radon concentrations varying from 0.43 pCi/l at 40 meters over a basin near the mountain ridge to 0.004 pCi/l at altitudes of nearly 8 km (MSL). The distribution over a mountain ridge follows that of potential temperature. Mountain slope heating is an important mechanism in the transport of air rich in ^{222}Rn from the canyons and basins near the mountains to higher levels as solar heating progresses during the morning hours. Turbulence created by lee waves is another mechanism responsible for carrying ^{222}Rn aloft. The first cumulus humilis clouds formed in the clear air above the mountains have a radon content in excess of their environment of approximately 25%. This appears to be supplied by air having a high radon content in updrafts below the cloud. Cumulus congestus exhibit patterns of activity that suggest an increase in radon flux into the cloud base over that found in the initial cloud development. Full-scale cumulonimbus systems may have an estimated total ^{222}Rn content of the order of 1.5 Ci in a volume of about 50 km^3. (auth)

20899 THE MEASUREMENT OF THE SIZE SPECTRUM AND CHARGE TO TOTAL RATIO OF CONDENSATION NUCLEI HAVING NATURALLY OCCURRING RADON DAUGHTER PRODUCTS ATTACHED TO THEM. Soilleux, P. J. (Radiological Protection Service, Sutton, Eng.). Health Phys.; 18: 245-54 (Mar 1970).

A large number of experiments was carried out under a variety of atmospheric conditions to measure the mobility, and hence the size spectrum, of atmospheric condensation nuclei having naturally occurring short-lived radon daughter product atoms attached to them. The ratio of the number of charged nuclei (particles) of a particular sign to the total number of particles present was also measured. The numbers of charged particles within a series of mobility, and hence size ranges, were measured by electrical separation and by counting the α-particle disintegrations associated with these particles. The size spectra for both positive and negative nuclei were similar and diameter ranged from about 0.02 μ to about 0.15 μ. The size spectrum for both positive and negative particles varied with atmospheric conditions, but the range of particle diameters remained fairly constant. The ratio of the number of positively and negatively charged particles to the total number of particles varied with atmospheric conditions, and the percentage number of positively charged particles was generally about twice that of negatively charged particles. The number of positively charged particles present was, however, found to be as high as 95% during a snowstorm. (auth) (UK)

20900 ASSESSMENT OF GAMMA-EXPOSURE DUE TO RADIOACTIVE CLOUD RELEASED FROM A POINT SOURCE. Imai, Kazuhiko; Iijima, Toshinori (Japan Atomic Energy Research Inst, Tokai). Health Phys.; 18: 207-16(Mar 1970).

Some models proposed for simple calculations of exposure due to a radioactive cloud cannot take care of all aspects of the ground-level exposure, so a precise computation was carried out with an electronic computer. Nuclide concentration in the cloud was assumed to be of the Gaussian-type, and the cloud size parameters were formulated on the basis of Pasquill's graphical data. Calculated results are discussed in relation to atmospheric stability, height of release point, energy of photon, etc. The downwind exposure in the vicinity of the release point does not depend on the stability. Places where the maximum exposures are expected appear much closer to the release point than those where the maximum concentrations are expected. They are approximately proportional to the -1.2 power of the height of the release point for any stability condition. Energy-dependence of the exposure is not simple and the approximation of linearity with energy is not always acceptable. (auth) (UK)

20901 ATMOSPHERE–HYDROSPHERE CYCLES OF TRITIUM UNDER MIDDLE LATITUDES SINCE 1952. Bosch, Bernard (Univ., Paris); Guegan, Bernard; Hubert, Pierre; Olive, Philippe; Siwertz, Erik; Marce, Adrien. Compt. Rend., Ser. D; 270: 267-70(12 Jan 1970). (In French).

A set of ratios has been established between the annual tritium fallout values in Canada (measured since 1952) and those in a number of European stations (measured since 1958). The yearly average of these ratios varies from 1.0 to 2.4. A study of the variation of these ratios as a function of time shows the appearance of a heterogeneity in the fallout values between Canada and Europe after each group of thermonuclear explosions. If no more large thermonuclear tests take place, the mean annual tritium concentrations in rainfall should tend towards 150 to 100 TU in the next few years. (auth) (France)

20902 VARIATION OF RADIOSTRONTIUM ISOTOPE RATIOS IN ATMOSPHERE. Cooper, Wilson Wayne. Fayetteville, Ark.; Univ. of Arkansas (1969). 107p. Thesis.

The $^{89}Sr/^{90}Sr$ and $^{140}Ba/^{90}Sr$ ratio variations in rain were studied at Fayetteville, Arkansas between September 1, 1967, and January 1, 1969. The stratospheric residence time for ^{90}Sr was calculated to be 1.08 year (stratospheric residence half-time = 0.75 year) based on the ^{90}Sr data in this study and on that from previous studies carried out in this laboratory since 1958. A simple relationship was found to exist between the ^{90}Sr inventory in the stratosphere ($\overline{C}_S$) and the annual average ^{90}Sr concentration in rain ($\overline{C}_R$): $\overline{C}_R = \overline{C}_S \cdot K_S \cdot 10/\Sigma R$ where $1/K_S$ is the mean residence time of ^{90}Sr in the stratosphere and ΣR is the annual average rainfall (in meters) and $\overline{C}_R$ and $\overline{C}_S$ are expressed in 10^{-12} curies/l and 10^{-12} curies/cm^2, respectively. Good agreement between $\overline{C}_S$ and $\overline{C}_R$ was obtained, when the annual average rainfall in the southwestern part of the United States (ΣR = 593 mm) was used rather than the ten-year average value for Fayetteville, Arkansas, (ΣR = 1115 mm). A "fine structure" in the variation of the $^{89}Sr/^{90}Sr$ ratio in rain observed after the Chinese nuclear test of December 24, 1967, indicated that the fresh fallout particles were transported eastward and circle the earth several times. About two weeks were required per cycle. The transport of debris from the French tests during the summer, 1968, in the Southern Hemisphere was found to occur both via the troposphere and stratosphere, from the variation of the $^{89}Sr/^{90}Sr$ ratio variation in rain. The French test series increased the northern stratospheric inventory by about 1.6 per cent. (Disser. Abstr.)

20903 UPPER ATMOSPHERIC CURRENTS AND THE DEPOSITION OF RADIOACTIVE AEROSOLS IN THE ATMOSPHERE. Fox, Johannes M. (Medizinische Akademie, Luebeck, Ger.). Tellus; 21: 648-55(1969). (In German).

Measurements of the concentration of atmospheric radioactivity show a distinctly seasonal variation of the course of the vertical profiles. In spring the concentration of radioactivity increases rapidly with altitude when passing from the upper troposphere into the lower stratosphere. In summer the increase is only moderate, in autumn it is low, but in winter a greater increase is observed, which reaches its maximum value during spring. Additionally a special evaluation of the worldwide ^{90}Sr data (1958 to 1965) indicates that the meridional transport of radioactive aerosols depends on the meridional distribution of the zonal wind velocity, and on the gradient of concentration created by the conditions of injection of radioactive debris from nuclear tests. Thus one may conclude, that the process of eddy diffusion is the main cause of the meridional transport and the vertical deposition of radioactive aerosols from the stratosphere. In the spring the lower stratosphere is filled by a greatly enlarged supply of radioactive material, but in the autumn the stratosphere is depleted because of the lack of supply. A tropopause mechanism is not at all necessary if the fallout phenomena are considered in this "dynamic" manner. (auth) (Sweden)

20904 LONG-LASTING RADIOACTIVITY AT HIGH ALTITUDE (JANUARY 1, 1967 TO DECEMBER 31, 1968). Keck, Gertrud; Krocza, W.; Kuester, M. (Tieraerztliche Hochschule, Vienna). Wien. Tieraerztl. Monatsschr.; 56: 290-2(Sep 1969). (In German).

Since 1963 total long-lived β-activity of air has been regularly measured at two high altitude monitoring stations in Austria (Weibsee, 2300 m, and Schneiderau, 1041 m). Sampling of precipitations for ^{137}Cs has been carried out since 1966. Results from 1967 and 1968 are reported and discussed. It has been confirmed that radioactive particles from nuclear weapons tests are more readily detected at high altitude than at low altitude stations. (auth)

Mineralogy and Exploration

Refer also to abstract 20731.

20905 CONTRIBUTIONS TO THE PROCESS OF RADIOMETRIC TESTING OF URANIUM DEPOSITS. Lungu, A. Stud. Cercet. Geol., Geofiz., Geogr., Ser. Geofiz.; 7: No. 1, 107-24(1969). (In Rumanian).

A brief survey is made of the results obtained with a new method using the gamma intensity "gradient" along a measurement cross section running through a zone of radioactive mineralization. It is economic and provides an accurate estimate of the boundaries of the mineralized area. The method has been successfully employed in many instances when standard procedures had failed. (Rom. Sci. Abstr.)

20906 GENESIS OF URANIUM IN THE ATHABASCA REGION AND ITS SIGNIFICANCE IN EXPLORATION. Beck, L. S. (Saskatchewan Dept. of Mineral Resources, Regina). CIM (Can. Mining Met.) Bull.; 367-77(Mar 1970).

The Athabasca region forms part of the Churchill province of the Canadian Shield and is underlain by an Archean or Aphebian assemblage of rocks that underwent severe metamorphism and granitization during the Hudsonian orogeny (1750 to 1950 Myr ago). In places, the eroded orogen is overlain by unmetamorphosed cover rocks (including the Martin and Athabasca formations) of probable Paleohelikian age. Basic dykes cut all the rocks of the region. There are innumerable vein-type pitchblende deposits and many syngenetic occurrences of uraninite in crystalline basement rocks. Evidence is presented to show that pitchblende was emplaced during the final stages of the Hudsonian granitization and followed the crystallization of syngenetic uraninite transitionally. In terms of P–T conditions, the pitchblende deposits belong essentially to Lindgren's mesothermal group. Based on the postulated uranium metallogenesis, the possibilities of finding further deposits of pitchblende and other types of uranium deposits are discussed. (auth) (Canada)

20907 EVALUATION OF THE RADIOACTIVE EQUILIBRIUM RATE AND QUANTITATIVE DETERMINATION OF URANIUM AND RADIUM IN URANIFEROUS ORES BY GAMMA SPECTROMETRY. Richard, Pierre; Voinot, Herve; Canivet, Claudine; Jurain, Georges; Coppens, Rene (Ecole Nationale Superieure de Geologie Appliquee et de Prospection Miniere, Nancy). Compt. Rend., Ser. D; 270: 25-7(5 Jan 1970). (In French).

The study of the radioactive equilibrium rate of the uranium-radium family is made possible by means of the data obtained through the analysis of uraniferous ores by gamma spectrometry. (auth) (France)

Oceanography

Refer also to abstracts 20889, 20891, and 21099.

Seismology

20908 (JAB–99–51) STRUCTURAL EFFECTS OF THE FAIRBANKS, ALASKA EARTHQUAKE OF JUNE 21, 1967. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Mar 1970. Contract AT(26-1)-99. 39p. Dep. CFSTI.

An earthquake with three primary shocks of Richter magnitudes 5.4, 5.6, and 5.4 (U. S. Coast and Geodetic Survey) occurred 15 kilometers east southeast of Fairbanks, Alaska, on June 21, 1967. The earthquake caused slight to moderate damage to structures in Fairbanks and at nearby Ft. Wainwright. Ground motion was felt over an area of 90,000 square miles, extending as far as Anchorage, 415 kilometers to the southwest. The Fairbanks earthquake was assigned a maximum Modified Mercalli intensity of VII by the U. S. Coast and Geodetic Survey. The three primary shocks evidently had the same epicenter location, 64.8° N, 147.7°W. Aftershocks, which continued for several days, had a common epicenter which was located close to the epicenter of the three major shocks. Damage reported consisted essentially of cracked and displaced walls, broken panes of glass, and fallen ceiling tiles and panels. No street damage was reported, although there was one case of earth subsidence at Ft. Wainwright. (auth)

20909 (PNE-R–18) SEISMIC MOTIONS FROM PROJECT RULISON. Loux, Peter C. (Environmental Research Corp., Alexandria, Va.). [1970]. 19p. (CONF-700101–10). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

In the range from a few to a few hundred kilometers, seismic measurements from the Rulison event were found and compared with experimentally and analytically derived pre-event estimates. Seismograms, peak accelerations, and response spectra are given along with a description of the associated geologic environment. Techniques used for the pre-event estimates are identified with emphasis on supportive data and on Rulison results. Of particular interest is the close-in seismic frequency content which is expected to contain stronger high frequency components. This higher frequency content translates into stronger accelerations within the first tens of kilometers, which in turn affect safety preparations. The local geologic structure at nearby population centers must be considered. Pre-event reverse profile refraction surveys are used to delineate the geology at Rifle, Rulison, Grand Valley, and other sites. The geologic parameters are then used as input to seismic amplification models which deliver estimates of local resonant frequencies. Prediction of such resonances allows improved safety assurance against seismic effects hazards. (auth)

20910 RESIDUAL STRAINS ASSOCIATED WITH A NUCLEAR EXPLOSION. Romig, P. R. (Colorado School of Mines, Golden); Major, W. M.; Wideman, C. J.; Tocher, Don. Bull. Seismol. Soc. Amer.; 59: 2167-76(Dec 1969).

Two quartz-bar strainmeters were entrenched north of Beatty, Nevada to observe the Benham underground nuclear test of December 19, 1968 (M = 6.3). These instruments, oriented approximately radially to the source, were located at distances of 28 kilometers and 71 kilometers from ground zero. Construction began on December 4, was completed by December 16, and good records were obtained during the test. Step-like residual strains of 1.8×10^{-7} and 0.35×10^{-7}, respectively, were recorded. These results agree with those reported for earthquakes of M = 6.2. They also tend to substantiate the decay with distance law of $R^{-\frac{5}{2}}$ observed for earthquakes as opposed to the theoretical R^{-3}. A most significant observation was that, whereas earthquake steps do not decay within several days if at all, the strain step from Benham apparently decayed to near zero within half an hour. This decay with time appears to be a reflection of the pressure history of the cavity. (auth)

20911 MICROEARTHQUAKE ACTIVITY IN EASTERN NEVADA AND DEATH VALLEY CALIFORNIA BEFORE AND AFTER THE NUCLEAR EXPLOSION BENHAM. Molnar, Peter; Jacob, Klaus; Sykes, Lynn R. (Lamont-Doherty Geological Observatory, Palisades, N. Y.). Bull. Seismol. Soc. Amer.; 59: 2177-84(Dec 1969).

Six portable, high-gain, high-frequency seismographs were operated in Nevada and California for several weeks before and after the underground nuclear explosion Benham to assess the possibility that earthquakes at distances of tens of kilometers or more may be triggered by large underground explosions. A pronounced increase in earthquake activity in the vicinity of the shot point was observed immediately after the detonation and continued for more than a month after the explosion. No significant change in activity within 25 km of any of the instruments northeast of the Nevada Test Site was observed, and the activity in Death Valley recorded after the explosion did not indicate an important increase. These data imply that this particular explosion did not significantly affect the seismicity of the region studied. Throughout the period of observation the seismic activity northeast of the Nevada Test Site was low; an average of about one event per day was detected within about 25 km of each station. This suggests that the current tectonic activity of this part of Nevada is lower than that of western Nevada and of most other tectonically active regions where microearthquake studies have been made. (auth)

20912 TRANSIENT AND RESIDUAL STRAINS FROM LARGE UNDERGROUND EXPLOSIONS. Smith, Stewart W.; Archambeau, Charles B.; Gile, William (California Inst. of Tech., Pasadena). Bull. Seismol. Soc. Amer.; 59: 2185-96(Dec 1969).

Tectonic strain readjustments associated with large underground explosions have been observed at the Nevada Test Site. The Benham event of December 19, 1968 produced a peak quasi-static radial strain of 1.2×10^{-7} at a distance of 29 km. This strain transient was followed by an exponential return to the initial state with a time constant of 13 minutes, and is interpreted as the direct elastic response of the medium to a time varying pressure in the Benham cavity. An upper bound on the tectonic strain release was determined to be 0.7×10^{-8}. Using these measurements it is estimated that the permanent and quasi-static strains associated with this explosion could significantly effect local earthquake occurrences out to distances of about 15 km. The size distribution of aftershocks of this explosion resembles that seen in model experiments of brittle fracture, in which the distribution is controlled by the dimensions of inhomogeneities in the medium. (auth)

20913 NEAR-FIELD AND FAR-FIELD SEISMIC EVIDENCES FOR TRIGGERING OF AN EARTHQUAKE BY THE BENHAM EXPLOSION. Aki, Keiiti; Reasenberg, Paul; DeFazio, Thomas; Tsai, Yi-ben (Massachusetts Inst. of Science and Tech., Cambridge). Bull. Seismol. Soc. Amer.; 59: 2197-2207(Dec 1969).

A wide-band (0.03 to 10 cps) accelerometer system was used for recording seismic motions at a distance of 18 km from the underground nuclear explosion Benham. The records clearly show a unique difference in spectral structure between the radial and transverse components of horizontal motions. The source of the transverse component appears to be a more efficient radiator of long waves than the source of the radial component, strongly suggesting that the transverse component motion may not be due to transformation of P, SV or Rayleigh waves but due to an additional source which was triggered by the explosion. Combining the result from Love wave spectra observed at Weston, Massachusetts, we arrived at the following conclusions: a faulting was triggered by the explosion in such a timing that the shear waves from the starting point of fault arrived at our station 3 seconds after the arrival of the explosion-generated shear waves; the size of faulting es-

timated from long-period surface waves is such that the product of fault area and dislocation is about 10^{13} cm^3. This value is consistent with the length, displacement and depth of faulting as suggested from field observations and aftershock studies. An alternative theory which postulates a release of high pre-existing stress (400 to 3000 bars) by the formation of a crushed region can account for the seismic moment estimated from long-period Love waves observed at a long distance. This theory, however, does not harmonize with observations on surface faulting and aftershocks. (auth)

20914 GEOLOGIC EFFECTS OF THE BENHAM UNDERGROUND NUCLEAR EXPLOSION, NEVADA TEST SITE. Bucknam, R. C. (Geological Survey, Denver). Bull. Seismol. Soc. Amer.; 59: 2209-19 (Dec 1969).

The Benham event, an underground nuclear explosion with a yield of about 1 megaton, produced linear fracture zones along previously mapped Basin and Range faults as far as 5.6 km (kilometers) from the explosion. The sense of vertical displacement on the faults and associated fractures is usually the same, with as much as 46 cm (centimeters) of vertical displacement and 15 cm of right-lateral displacement on the fractures. Displacements on the fractures reflect the release of tectonic strain triggered by the explosion; the parameters of the principal zone of fractures are similar to those expected for a natural earthquake of magnitude M = 6.0, which is also the instrumentally determined magnitude for the explosion reported by the U. S. Coast and Geodetic Survey. (auth)

20915 STRAIN ASSOCIATED WITH THE BENHAM UNDERGROUND NUCLEAR EXPLOSION. Dickey, D. D. (Geological Survey, Denver). Bull. Seismol. Soc. Amer.; 59: 2221-30 (Dec 1969).

The Benham, underground nuclear explosion, with a yield of 1.1 megaton equivalent TNT, caused apparent release of natural tectonic strain at the Earth's surface in decreasing amounts out from the explosion point. Strain changes were measured on quadrilaterals about 1 km (kilometer) on a side at six different localities. Maximum extension of 521×10^{-6} was measured 1 km from the explosion and 33×10^{-6} was measured at 11 km. Maximum strain at each measured location, plotted against distance from the explosion, gave the equation $\log\epsilon = -3.2823 - 0.1087\,d$, where ϵ is strain and d is distance in kilometers. Strain changes measured at distances greater than 5 km appear to be fault controlled and are believed to result from release of tectonic strain. A level line across the area of the explosion showed fault-controlled subsidence of an area, more than 3 km wide in an east-west direction, and probable slight uplift of the area to the east of the fault that is the eastern boundary of the subsidence. (auth)

20916 FAULT DISPLACEMENTS AND MOTION RELATED TO NUCLEAR EXPLOSIONS. McKeown, F. A.; Dickey, D. D. (Geological Survey, Denver). Bull. Seismol. Soc. Amer.; 59: 2253-69 (Dec 1969).

Studies of some of the geologic effects of underground nuclear explosions are summarized. Movement has been triggered on some faults within a few thousand feet of explosions in Nevada and in Amchitka Island, Alaska. The permanent relative vertical displacement on the faults always has been in the same direction as the last recognizable natural tectonic displacement and has been as much as 1 m (meter); horizontal displacement of as much as 15 cm (centimeters) has occurred on a few faults although no previous horizontal displacement had been apparent. The strike length of triggered faulting ranges from about 1 to 8 km (kilometers) and seems to correlate linearly with yield and magnitude of the explosions. High-speed motion picture photography of two faults from both the air and the ground provides the following data on the motion of the faults: fault motion started at the first arrival of seismic energy; rupture velocity along triggered faults, measured over a distance of 0.210 km, was 2.1 km/sec (kilometers per second) in alluvium of Hot Creek Valley, Nevada, which has a compressional velocity that ranges from about 2 km/sec to 3.3 km/sec and which has a density of 2.3 g/cc; and the velocity of displacement of alluvium at the Yucca fault plane in Yucca Flat was a little more than 1 m/sec (meters per second). Velocity of displacement of alluvium at the fault plane in Hot Creek Valley was between 6 and 30 m/sec. (auth)

20917 AFTERSHOCKS OF THE BENHAM NUCLEAR EXPLOSION. Hamilton, R. M.; Healy, J. H. (National Center for Earthquake Research, Menlo Park, Calif.). Bull. Seismol. Soc. Amer.; 59: 2271-81 (Dec 1969).

The Benham nuclear explosion, a 1.1 megaton test 1.4 km beneath Pahute Mesa at the Nevada Test Site, initiated a sequence of earthquakes lasting several months. The epicenters of these shocks were located within 13 km of ground zero in several linear zones that parallel the regional fault trends. Focal depths range from near surface to 6 km. The earthquakes are not located in the zone of the major ground breakage. The earthquake distribution and fault plane solutions together indicate that both right-lateral strike-slip fault movement and dip-slip fault movement occurred. The explosion apparently caused the release of natural tectonic strain. (auth)

20918 AMPLITUDE AND FREQUENCY CHARACTERISTICS OF ELASTIC WAVE TYPES GENERATED BY THE UNDERGROUND NUCLEAR DETONATION, BOXCAR. Hays, W. W. (Environmental Research Corp., Alexandria, Va.). Bull. Seismol. Soc. Amer.; 59: 2283-93 (Dec 1969).

Elastic wave types generated by the BOXCAR underground nuclear detonation were identified and analyzed to determine their amplitude and frequency characteristics as a function of distance. The amplitude characteristics of the identified wave types were determined to vary with source to recording station distance and frequency. Within each body wave subset, the refracted wave amplitude decays most rapidly and the reflected wave amplitude least rapidly with distance. Fourier amplitude spectra of the P, S, and surface wave time windows exhibit maxima which occur at different spectral frequencies for stations on rock, ranging from a dominant frequency of about 0.8 Hz for the P-wave window to about 0.25 Hz for the surface wave window. The frequency of the maximum amplitude of each of the three wave mode window spectral sets is essentially unaffected by increase in propagation distance over the distance range 22.2–79.1 km. (auth)

20919 RESPONSE SPECTRA FOR PAHUTE MESA NUCLEAR EVENTS. Lynch, Robert D. (Environmental Research Corp., Alexandria, Va.). Bull. Seismol. Soc. Amer.; 59: 2295-2309 (Dec 1969).

Empirical equations for the prediction of pseudo-relative velocity response spectra (PSRV) are obtained from ground motions recorded at 64 seismic stations from 11 nuclear events detonated on Pahute Mesa at the Nevada Test Site (NTS). The spectra are related to the yield of the nuclear device and the distance between the source and receiver by multiple regression analysis. Exponents on yield and distance are derived at 40 separate periods in the period range from 0.05 to 2.469 seconds. Families of predicted mean PSRV curves are included to show the spectral development as a function of yield and distance. (auth)

20920 SEISMIC ENERGY EFFICIENCY OF UNDERGROUND NUCLEAR DETONATIONS. Mueller, R. A. (Environmental Research Corp., Alexandria, Va.). Bull. Seismol. Soc. Amer.; 59: 2311-23 (Dec 1969).

The amount of energy going into the formation of elastic waves in the far field radiation zone was determined for the underground nuclear explosions Boxcar, Benham, Salmon, Schooner, Shoal, and Sterling. The method is based on Sharpe's spherically symmetric model. The analytical solution of Sharpe's problem is developed into an energy equation and applied to the experimental results. The results obtained in this manner are in the same range found by other investigators. A basic conclusion is that seismic energy efficiency appears to be significantly lower for cratering events than for contained events. (auth)

20921 ANALYSIS OF SEISMIC PEAK AMPLITUDES FROM UNDERGROUND NUCLEAR EXPLOSIONS. Murphy, J. R.; Lahoud, J. A. (Environmental Research Corp., Alexandria, Va.). Bull. Seismol. Soc. Amer.; 59: 2325-41 (Dec 1969).

Ground-motion data recorded from 99 underground nuclear events ranging in yield from about 1 to 1200 kilotons are analyzed. The data were measured at more than 500 different stations with the source-to-station distance ranging from less than 1 to approximately 600 kilometers. More than 2,900 acceleration, displacement and velocity peak resultant vector data points are included in the analysis. A comparison of the results of the statistical analysis with expected results using cube-root of yield scaling concepts, shows that the peak amplitude of displacement cube-root scales whereas peak acceleration and velocity do not cube-root scale. Relative differences in the yield and distance exponents, n and m, obtained from the statistical analysis are explained in terms of differences in the frequency content of recorded ground motions. The observed peak amplitude measurements from the events Boxcar and Benham are compared with predictions based on the statistical analyses. (auth)

20922 RESPONSE OF HIGHRISE BUILDINGS TO GROUND MOTION FROM UNDERGROUND NUCLEAR DETONATIONS. Blume, John A. (John A. Blume and Associates, San Francisco). Bull. Seismol. Soc. Amer.; 59: 2343-70 (Dec 1969).

Typical data obtained thus far in the AEC nuclear test program on the response of highrise Las Vegas buildings to ground motion

from distant nuclear events including Boxcar and Benham are presented, together with measured building response to distant earthquakes and to wind gusts. Major variations in response spectra are shown over the city for a specific event, from period band to period band at the same location for different events, and statistical parameters are shown for the randomness of spectral response. The peak response of tall buildings is shown for the top levels in translation and in orbital motion, and in the vertical plane with simultaneous multi-level measurements. The variation of peak modal response is shown with elapsed time, modal combinations are noted, and an example of time-history computed response is compared to measured response. It is shown that highrise Las Vegas buildings respond to ground motion with considerable amplification, that the fundamental modes tend to dominate the peak responses although there are exceptions, that there can be significant modification of loading conditions because of simultaneous motion in the two horizontal axes even though a building is symmetric, and that some building periods vary with amplitude and history of non-damaging prior response while others do not. In general there are indications that code earthquake design criteria are by no means conservative. (auth)

20923 GROUND EFFECTS FROM THE BOXCAR AND BENHAM NUCLEAR EXPLOSIONS. Cloud, William K.; Carder, D. S. (ESSA–ERL, San Francisco). Bull. Seismol. Soc. Amer.; 59: 2371–81 (Dec 1969).

Formulas were developed in 1957 for the purpose of estimating maximum ground accelerations and transitory displacements, resulting from the 1.7 kt Rainier shot and subsequent underground nuclear detonations. These formulas when extrapolated more than 4 orders of magnitude upward came within a half order of magnitude of predicting ground motion data resulting from the Boxcar and Benham underground detonations. Velocity response spectra from these shots made in the distance range of 20 km, more or less, closely resembled the velocity response spectra from a magnitude 6.6 earthquake in the same distance range. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 20878, 20879, 20885, 20889, 20909–20923, 20942, and 21039.

20924 (AD–481165) AERIAL SURVEY OF THE CONTAMINATED OCEAN SURFACE AT OPERATION WIGWAM, WITH DOSE RATE CONTOUR LINES THROUGH D +4 DAYS. Kehrer, W. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb 1966. 54p. (USNRDL–TR–981). CFSTI.

Aerial survey was utilized to measure the radiation intensities above the contaminated pool at operation Wigwam. These field data were used to provide a detailed analysis of the radiation field at 3 ft above the surface through D + 4 days, and to determine the hazard to personnel on board ships traversing the area. (USGRDR)

20925 (AD–699420) SOME PROPERTIES OF RADIOACTIVE FALLOUT: TOWER DETONATIONS DIABLO AND SHASTA. Miller, Carl F. (URS Research Co., Burlingame, Calif.). Aug 1969. Contract DAHC20-69-C-0142. 84p. (URS–757-3). CFSTI.

Decay and specific activity data on fallout particles with diameters ranging from 100 to 10,000 microns from Shots Diablo and Shasta have been summarized and correlated. Essentially all the radioactive elements were concentrated in melted magnetic particles with iron oxide contents of about 5 percent on a weight basis. Ionization rate decay, gamma count-rate decay, and gross fractionation curves for a unit equivalent of fission based on ^{99}Mo content of the fallout samples were derived for time periods ranging from 15 minutes to about 1,000 days (2.7 years) after detonation. (USGRDR)

20926 (PNE-G–54) GASBUGGY RESERVOIR EVALUATION, 1969 REPORT. Atkinson, C. H.; Ward, Don C. (Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center); Lemon, R. F. (El Paso Natural Gas Co., Tex.). 1 Dec 1969. 13p. (CONF-700101–7). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

The December 10, 1967, Project Gasbuggy nuclear detonation followed the drilling and testing of two exploratory wells which confirmed reservoir characteristics and suitability of the site. Reentry and gas production testing of the explosive emplacement hole indicated a collapse chimney about 150 feet in diameter extending from the 4,240-foot detonation depth to about 3,900 feet, the top of the 300-foot-thick Pictured Cliffs gas sand. Production tests of the chimney well in the summer of 1968 and during the last 12 months have resulted in a cumulative production of 213 million cubic feet of hydrocarbons, and gas recovery in 20 years is estimated to be 900 million cubic feet, which would be an increase by a factor of at least 5 over estimated recovery from conventional field wells in this low permeability area. At the end of production tests the flow rate was 160,000 cubic feet per day, which is 6 to 7 times that of an average field well in the area. Data from reentry of a preshot test well and a new postshot well at distances from the detonation of 300 and 250 feet, respectively, indicate low productivity and consequently low permeability in any fractures at these locations. (auth)

20927 (PNE-G–58) AN EVALUATION OF WATER PRODUCTION FROM THE GASBUGGY REENTRY WELL. Power, Dean V.; Bowman, Charles R. (El Paso Natural Gas Co., Tex.). [1969]. 26p. (CONF-700101–11). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

During the gas production testing of the Gasbuggy chimney, water production rates increased from an initial 4 to 5 barrels per 10^6 standard cubic feet of gas to 40 to 50 barrels per 10^6 standard cubic feet of gas. This unexpected occurrence hampered operations and increased waste disposal costs. A model is developed which calculates the amount of water produced from condensation of water vapor through the cooling and expansion of the gas in the production tubing. Results from this model are compared with the observed water production from November of 1968 through May of 1969. This comparison shows that up to seven times more water is being produced at high gas flow rates than can be explained by condensed vapor, indicating that water is being introduced into the production tubing in particulate or liquid form. A correlation of excess water with the pressure, temperature and gas flow velocity parameters is performed to determine the relationship between this excess water and these parameters. It is found that the excess produced water varied linearly with downhole pressure when a threshold gas flow velocity was exceeded. The relationship is expressed by the equation H_2O (in barrels per day) = 126.5 − 0.1473 BHP (in pounds per square inch). The threshold gas velocity for excess water production was found to be about 6 feet per second in the 7″ casing or 40 feet per second in the 2⅞″ tubing. An examination of the radioactivity of the gas and water produced from GB-E indicates that the tritiated water vapor in the chimney and tubing has been diluted by extraneous water. Examination of water chemistry, preshot and during the production testing, indicates that at early times when there was no excess water, the produced water was distilled. At times of high water production, the trace chemical constituents are characteristic of undistilled water from the Ojo Alamo Formation (SO_4 concentrations of about 3000–5000 ppM). It is concluded that a decrease in the bottom hole pressure of GB-E resulted in Ojo Alamo water entering GB-E and either being produced or flowing down GB-E into the chimney. Preliminary analyses from data obtained during the test period of October and November 1969 indicate that the leak in GB-ER has been sealed, water production during this period corresponds to the calculated vapor model, water levels have risen to near normal in the Ojo Alamo and tritium levels in produced water have increased to 0.5 μCi/ml. (auth)

20928 (UCRL–50765) DRILLING INVESTIGATION OF THE LOWER PART OF THE PILEDRIVER CAVITY. Sterrett, Thomas S. (California Univ., Livermore. Lawrence Radiation Lab.). 20 Nov 1969. 20p. Dep. CFSTI.

A core-drilling program was conducted to investigate the postshot condition of the rock in the vicinity of the lower part of the cavity produced by the Piledriver nuclear shot (61 kt at a depth of 1500 ft in granite). Three holes were drilled, with good core recovery from each. The cores are presently under detailed study to determine rock failure mechanisms and radiochemical-mineralogical associations. It is apparent that the radius of the lower hemisphere of the cavity is considerably less than was previously thought. It was found to be 131.5 ft as compared with 160 ft previously inferred on the basis of observations made at a higher level. Earlier mining explorations at a level 105 ft above the shot point had encountered the chimney wall 160 ft out from a vertical line through the detonation point. This suggests a cavity-chimney configuration whose walls slope outward about 15° from vertical as they go up. How far up this slope continues and whether the chimney is symmetrical are questions that cannot yet be answered. (auth)

20929 (UCRL–71824) SYSTEM FOR THE MEASUREMENT OF DEPOSITION AND RESUSPENSION OF RADIOACTIVE PARTICULATE RELEASED FROM PLOWSHARE CRATERING EVENTS. Holladay, G.; Bishop, S.; Phelps, P.; Anspaugh, L. (California Univ., Livermore. Lawrence Radiation Lab.). 13 Nov 1969. 19p. (CONF-691017–10). Dep. CFSTI.

From 16th Nuclear Science Symposium, San Francisco, Calif.

Potential benefits to man from the use of nuclear explosives for excavation are considerable. Proposed applications actively being studied under the Plowshare Program include construction of canals, harbors, and dams. Potential economic advantages of nuclear explosives over conventional chemical explosives and excavation machinery are so great as to permit consideration of projects otherwise entirely unfeasible. However, the use of nuclear explosives in excavation projects implies the potential release of radioactivity into the biosphere. The biological implications of such releases must be evaluated before any nuclear excavation project can be seriously considered. The Lawrence Radiation Laboratory is pursuing investigations intended to systematically analyze the effects on the biosphere of the release of radionuclides from experimental Plowshare cratering events. Data from these studies will be used to evaluate and refine existing predictive methods. (auth)

20930 (UCRL–72153) GAS QUALITY ANALYSIS AND EVALUATION PROGRAM FOR PROJECT GASBUGGY. Smith, C. F. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Dec 1969. 19p. (PNE-G–55; CONF-700101–14). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

Experimental results of the gas quality analysis program for Project Gasbuggy through August 1969 are presented graphically, addressing the questions raised by the preshot program goals. The chemical composition and the concentrations of tritium, krypton-85, carbon-14, and argon-37, 39 are presented as a function of time and gas production from the nuclear chimney. Chemically, the presence of CO_2, CO, and H_2 served to dilute the for-

mation gas and caused reactions that significantly altered the gas composition at early times. The radionuclide content of the chimney gas at reentry was some 800 pCi/cm³ of which about 80% was CH_3T. Lesser quantities of tritium were observed as HT, C_2H_5T, and C_3H_7T. The other major contaminant was ^{85}Kr which was present at about one-fifth the level of CH_3T. Small quantities of carbon-14 and argon-39 were also identified. The only other radionuclides identified in the gas were relatively short-lived rare gases. During the production testing, about two and one-half chimney volumes of gas at formation pressure were removed. This removal, accompanied by dilution, reduced the radionuclide concentrations to about 7% of their levels at reentry. The production characteristics of the Gasbuggy environment prevented an adequate test of the effectiveness of chimney flushing. However, the rapid drawdown concept is supported by the available data as an effective means of reducing contaminant levels. The changes in composition during production or testing are seen to be consistent with a model involving a nonuniform gas influx rate and flow distribution over the chimney region. Mixing times are estimated to be on the order of a few days, so that increasing concentrations following a sudden gas influx can be explained. (auth)

20931 MISSION PROFILES FOR THE EXPLORATION OF THE OUTER SOLAR SYSTEM WITH NUCLEAR PULSE ROCKETS. Smith, J. N. (Lockheed Missiles and Space Co., Sunnyvale, Calif.); Mead, C. W. Ann. N. Y. Acad. Sci.; 163: 442-52(4 Sep 1969).

The mission profiles and possibilities that would become available with the development of a nuclear pulse system are discussed. It is suggested that the concept is feasible and should be given serious consideration when the decision is made to explore the outer solar system. The nuclear pulse propulsion concept is based on the explosion of small nuclear devices, or pulse units, external to the spacecraft. Acceleration of the spacecraft is provided by the resulting expanding, high-density, high-velocity plasma from the explosion. The principle of operation for the vehicle under consideration is described. The pulse units are stored within the vehicle and ejected through the base, or pusher plate, and detonated some distance behind the vehicle. Some of the high-velocity plasma impinges on the pusher plate with a momentum which is rapidly transferred to the plate, resulting in a high acceleration. Shock-absorbing devices smooth these accelerations to well within human tolerance. After compressing the shock absorbers, the pusher plate returns to the neutral position for another pulse. Energy requirements for missions to the outer solar system are considered on the basis of velocity requirements and trip times. Travel time vs energy can be aligned by using a planetary swingby trajectory using Jupiter's gravitational field as the perturbing element. This will permit the outer regions of the solar system to be reached within a reasonable travel time (compared to the minimum-energy case) with a significant reduction of Earth-departure velocity. The shortest direct one-way mission that can be flown to Pluto, using a chemical system with a mass ratio of 10 and a characteristic velocity of 0.56 EMOS, requires a trip time of approximately 10 yr as compared to a minimum trip time of 2.4 yr for the nuclear pulse vehicle with the same mass ratio. (BBB)

20932 SUBSIDENCE RELATED TO UNDERGROUND NUCLEAR EXPLOSIONS, NEVADA TEST SITE. Houser, F. N. (Geological Survey, Denver). Bull. Seismol. Soc. Amer.; 59: 2231-51(Dec 1969).

The mechanism of collapse of nuclear explosion cavities for its value in containment is being investigated, with the hope of eventually determining those geologic environments most susceptible to early collapse or most adaptable to the incitation of collapse. The investigations to date have been confined largely to the subsidence of the ground surface in the desert alluvium of Yucca Flat by collapse of volcanic rocks and (or) alluvium into the large cavities formed by nuclear explosions. The sinks thus formed are as much as 60 m (meters) deep and 250 m in radius; they have forms that are commonly variations of inverted cones or sectors of spheres. The outer half of each sink is an inward slide of slightly disoriented but relatively undisturbed alluvium. The major physical disturbance within the slide mass is by subsidiary spoon-shaped cracks and slide surfaces along which individual blocks have adjusted within the glide mass. Each individual block moves a net distance that is small relative to the total movement of the main slide. The cracks or glide surfaces are assumed to flatten with depth within the slide and to join the major surface of failure at the base of the main slide mass. The spoon-shaped surfaces, where they intersect the top surface of the slide, dip steeply to vertically. In plan they make a pattern of curving, intersecting cracks. The depth of burial to the explosion cavity in alluvium relative to its size affects the profile of the sinks, the height of chimneys for collapses not extending to the surface, and, to an extent, the likelihood that later surface subsidence will occur. A working model of collapse includes: maintenance of the explosion cavity until main collapse occurs; a two-phase collapse taking place in several seconds or several tens of seconds, culminating in surface subsidence if the cavity is sufficiently close to the surface. The first phase of collapse in alluvium, at least, consumes 70–90 percent of the collapse period; collapse propagates upward at rates of 50–80 ft/sec. The second phase shows faster rates of upward propagation, a lesser degree of particulation of the collapse material, and ends with the drop of a central mass of alluvial material that initiates formation of the sink. The shape, size, and distance of vertical drop of this alluvial plug control the size and form the resulting sink. Acceleration of this mass ranges from 0.35 to 0.8 g. (auth)

20933 TOWARD COMMERCIAL PLOWSHARE. Nucl. Ind.; 16: No. 5, 9-17(May 1969).

The May 8 to 9, 1969 hearings before the Joint Committee on Atomic Energy held for the purpose of examining implementation of pending legislation which authorizes the AEC to offer commercial Plowshare services to U. S. and foreign industry are discussed. The witnesses were primarily officials of the AEC and State and Interior Departments. Highlights of the hearings included: presentation of an initial set of administrative procedures proposed by the AEC for review and approval of domestic commercial Plowshare projects; an offer by the nuclear liability insurance pools to line up $10 million of Plowshare insurance capacity, as a basis for extension of Price–Anderson indemnity direct to domestic users; a bid by the Interior Department for veto power over AEC commercial Plowshare activities that infuriated the Joint Committee, which viewed an all-out fight against the "power grab" if Interior pursues it; endorsement by the AEC and the State Department of a substantive role for the International Atomic Energy Agency in connection with nuclear explosion services to be made available to non-nuclear powers under the Non-Proliferation Treaty; and examination of the circumstances surrounding the postponement from May to September of Project Rulison. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 20963–20965, 20976, 21447, 21707, and 21734.

20934 (CEA-CONF-1422) TWO YEARS WORK OF THE RADIOMETALLURGY LABORATORY AT FONTENAY-AUX-ROSES. Hayet, L.; Poulain, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 18p. (In French). (SM-125/12; CONF-691008-10). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

A radiometallurgical laboratory, RM 2, is operated at Fontenay-aux-Roses for the examination of fuels from French fast neutron reactors and for the study of prototype fuels with irradiated Pu. After a brief description of the installations from the viewpoint of security, the principles concerning radiological controls, fire detectors, personnel equipment, coordination of operations, decontamination of cells, and transfer of radioactive material are described. Conclusions are drawn from the two years' operation and orientation of the modifications now being made is indicated. (tr-auth)

20935 (LA-4374) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1970. PART I. (Los Alamos Scientific Lab., N. Mex.). 20 Feb 1970. Contract W-7405-eng-36. 5p. Dep. CFSTI.

Results of investigations directed toward a better understanding of heat pipe operational principles are presented. Progress toward the design of a mercury space radiator having a heat-rejection capability that is temperature-dependent is reported. Tests are in progress on heat pipes with wicks consisting of layered woven wire screen. Results of calculations on heat transfer limitations imposed by sonic vapor flow, liquid entrainment, wicking ability, and boiling in the wick are presented for each wick. In other work, treatment of stainless steel pipes to prevent internal hydrogen buildup is reported. (J.R.D.)

20936 (LMEC-70-1) LIQUID METAL ENGINEERING CENTER (LMEC). Semiannual Technical Progress Report, July–December 1969. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 5 Mar 1970. Contract AT-(04-3)-700. 217p. Dep. CFSTI.

Activities in programs devoted to support of LMFBR develop-

ment are reported. Research and development efforts are summarized for projects on sodium-water reactions, components test installation operation, sodium pump test facility development, sodium pump operation technology, materials compatibility in sodium, heat exchanger performance, instrument development and calibration, chemistry and metallurgy, and maintenance and malfunctions. (J.R.D.)

20937 (SC-DR-70-59) QUICK, LOW-COST DEVELOPMENT TOOLING AND PARTS FROM PHOTOPOLYMER. Allen, T. A. (Sandia Labs., Albuquerque, N. Mex.). Mar 1970. 31p. Dep. CFSTI.

Photopolymer material, a photosensitive plastic which may be optically formed, can produce intricate and precise three-dimensional configurations quickly and economically by photographic principles. Its characteristics, processing requirements, and some of its applications in development-shop support of engineering activities are described. (auth)

20938 PERFORMANCE OPTIMIZATION OF A THERMIONIC NUCLEAR ELECTRIC PROPULSION SYSTEM FOR PLANETARY MISSIONS. Ingber, Jacob Frank. San Diego, Calif.; Univ. of California (1969). 199p.

Thesis.

The performance optimization of a thermionic nuclear electric propulsion system for planetary missions is studied. A major objective of the analysis is to provide a method for estimating reactor power requirements as a guide to the development of a thermionic power source. The performance optimization is composed of the dual problem of electric vehicle sizing and low-thrust trajectory optimization. A technique is described for solving the combined problem by effectively uncoupling the trajectory optimization and vehicle sizing providing a basis for easily computing optimum performance for a wide range of mission and system parameters. It is concluded that for preliminary design objectives, optimum trajectories for a given type mission need be computed only once to provide adequate performance information, regardless of parameter variations later introduced into the problem. A library of optimum solar system trajectories is generated and a method described for their use in computing optimum performance. A state-of-the-art nuclear electric system is modeled and representative sizing charts produced. A specific study using a Titan III F/Centaur launch vehicle for unmanned solar system missions determines that there is essentially a one-to-one correspondence between launch vehicles and power levels, regardless of the mission. The trade-offs and sensitivities of major system parameters are discussed. (Diss. Abstr. Int., B)

20939 NEW APPARATUS TO SHEAR BULK MATERIALS AT VARIOUS RATES UNDER VERY HIGH PRESSURE. Abey, A. E.; Stromberg, H. D. (Univ. of California, Livermore). J. Basic Eng.; 92: 137-8(Mar 1970).

The apparatus is described which will shear bulk materials at strain rates from 2×10^{-5}/sec to 5×10^{-1}/sec while the materials are under nearly hydrostatic pressures. This apparatus gives complete stress-strain curves in the plastic region at pressures from about 10 kbar to approximately 80 kbar. Data on beryllium are given as an example of the type of data available from this apparatus. (auth)

20940 AVARIINYE RABOTY NA KOMMUNAL'NYKH SETYAKH V OCHAGE YADERNOGO PORAZHENIYA. (Organization of the First Aid and Rehabilitation of Utilities in Nuclear Attack). Kammerer, Yu. Yu.; Kharkevich, A. E. Moscow; Izdatel'stvo Literatury po Stroitel'stvu (1969). 248p.

The economic characteristics of urban electric energy are discussed and the consequences of breakdown or damage to equipment are cited. Alarm systems are discussed. Water supply systems are described with recommendations for the protection of springs and simple measures for purification of water. Data are obtained from the civil defense engineering department. Organization of first aid systems following nuclear attack is discussed. (tr-auth) (TSS)

Heat Transfer and Fluid Flow

Refer also to abstracts 20935, 20936, and 21750.

20941 (ANL-7592) PULSED-BED APPROACH TO FLUIDIZATION. Kobayashi, Masaru (Argonne National Lab., Ill.). Oct 1969. Contract W-31-109-eng-38. 157p. Dep. CFSTI.

Thesis. Submitted to Northwestern Univ. [Evanston, Ill.].

An important objective of this investigation is to explore pulsed-bed characteristics that result from controlled, intermittent gas flow. Four sizes of glass beads, ranging from 73 to 580 μm in average diameter, were tested in 4-in.-OD, 1.25-in.-ID annular columns to find the unique characteristics of pulsed beds. Results of the investigation showed that the bed expansion ratios increase with gas velocity and decrease with pulse frequency and fraction of on-period; good particle motion exists below the minimum fluidizing velocity; and the stroke of the bed can be predicted from on-period, gas velocity, and minimum bubbling velocity. The characteristics of heat transfer from an internal heater to a pulsed bed have been studied regarding the effects of pulsing conditions, particle and gas properties, heater position, heater length, and static-bed height. Pulsed-bed operation has remarkable advantages in a heat-transfer process with large sizes and heavier particles, short heaters, and heaters located in the upper part of a bed. With the proposed heat-transfer mechanism model and the predicted bed stroke, the heat-transfer coefficients in a pulsed bed can be estimated. (auth)

20942 (FOA-4-4368) TRANSMISSION CAPABILITY FOR WHITE PAINTED AND UNCOATED WINDOW PANE GLASS OF HEAT RADIATION FROM NUCLEAR EXPLOSIONS. Onnermark, B.; Altvall, L. E. (Forsvarets Forskiningsanstalt, Stockholm (Sweden)). Aug 1968. 19p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

The influence of a white paint coating of a window pane on the radiant heat transfer from a nuclear explosion into a room is investigated. The aim was to create data and information to judge how this protective measure would reduce the number of ignition points inside a building. The investigation was done on a $1/_{10}$ scale model of a dwelling-house painted in four different colors using the sun as radiation source. Some primary measurement data were obtained that gave a rough intensity distribution in different locations and different directions in the dwelling-house. By comparing these data with ignition data for very inflammable indoor materials it was found that the investigated types of colors provided satisfactory protection. For comparison, measurements of radiant heat transmission were also done for uncoated window panes. (auth) (Sweden)

20943 VIBRATIONS OF A PENDULAR STRUCTURE OF CIRCULAR CROSS SECTION INSIDE A CONCENTRIC PIPE. Lazzeri, Luciano; Dini, Donato (CNEN, Rome). Ing. Nucl.; 10: No. 4, 48-57(Jul-Aug 1969).

The problem of vibrations of a pendulum of circular cross section inside a concentric pipe is discussed; it is shown that large eigen-frequency shifting can take place as a consequence of fluid presence. The possibility of application of PWR core barrel vibrations of the obtained results is suggested. (auth)

20944 STEADY TEMPERATURE DISTRIBUTION IN A HEAT-GENERATING MULTI-BORE CYLINDER. Takeuti, Yoitiro (Tokushima Univ., Japan). Nucl. Eng. Design; 11: 41-56(1969).

The approximate formulae for temperature distribution in heat-generating multi-bore circular and square cylinders are presented for the purpose of applying to an analysis of the thermal stress problems in these regions. (auth)

20945 DEPOSITION OF PARTICLES IN TURBULENT FLOW ON CHANNEL OR PIPE WALLS. Beal, S. K. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 40: 1-11 (Apr 1970).

A method for predicting the deposition of particles entrained in turbulent flow is presented. The method predicts the deposition of particles ranging from molecular size to ~100 μ in diameter. Brownian diffusion, turbulent diffusion, and inertial effects are accounted for, and the existence of an equilibrium concentration of particles close to the wall is postulated. The method shows reasonable agreement with published data. (auth)

20946 CRITICAL PARAMETERS FOR A HEAT TRANSFER MODEL FOR A ONCE-THROUGH SODIUM-HEATED STEAM GENERATOR. Brevi, Roberto (CNEN, Casaccia, Italy). Ing. Nucl., 10: No. 3, 37-60(May-June 1969). (In Italian).

The steam generator can be divided into several parts on the basis of the specific heat transfer process dominating that zone; these are the zone of preheating, the subcooled boiling zone, the mass boiling zone, annular mode boiling zone, thermal crisis point, ultracrisis zone, and superheated zone. The correlations proposed by various authors for each of these zones are presented and critically analyzed. These correlations are discussed and compared as much as possible with the experimental results. An evaluation is made of the difference resulting in the design as a result of the particular correlations selected. (J.S.R.)

Isotope Technology

Refer also to abstracts 20875–20877, 21343, 21434, 22021, 22362, 22434, and 22435.

20947 (AI-AEC-12926) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC). Tenth Quarterly Progress Report, October–December 1969. (Atomics International, Canoga Park, Calif.). 6 Feb 1970. Contract AT(29-2)-2338. 113p. Dep. CFSTI.

Activities in a program to develop an isotope fuel capsule capable of operation in space at a surface temperature of about 2000°F are summarized. Progress is reported on hardware design, capsule testing, and material compatibility testing. Efforts devoted to the various phases of the transient capsule support program are reported. (J.R.D.)

20948 (BNWL-1308-1) PACIFIC NORTHWEST LABORATORY DIVISION OF ISOTOPE DEVELOPMENT PROGRAMS. Quarterly Report, November 1969–January 1970. Sheely, W. F. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 42p. Dep. CFSTI.

The experimental evaluation of $^{147}Pm_2O_3$ compatibility with capsule materials was completed. The compatibility testing of various containment materials with Sm metal (stand-in for $^{147}Pm_2O_3$) was continued. The program on encapsulated waste management Cs as a process radiation source was redirected toward improved design of waste containers for efficient use as irradiation sources. Reconsideration of the shielding analysis showed that the quantitative evaluation of the effective source must be on the basis of target geometry as well as source geometry. Collection of data needed to obtain the half-life of ^{102m}Rh is continuing. Studies of methods for the nondestructive testing of irradiation sources concentrated on the development of a multielement, ultrasonic transducer which will permit scanning of wide paths in large, flat surfaces (such as plate-type irradiation sources) for internal defects. The electronic circuitry for signal generation, signal amplification, and transducer scanning was designed, built, and tested. Improved readout and display instrumentation is being developed. A portable neutron radiography device using ^{252}Cf was developed after analytical and experimental confirmation of the use of this source in such a device. The preparation of $^{241}AmO_2$ and UO_2 radiation sources was completed. A wide variety of source designs was fabricated. Preliminary tests demonstrated the feasibility of the sputtering process for deposition of radioisotope layers and isotope containment windows. The ^{238}Pu production cost studies continued by developing comparisons of Np irradiations in power reactors with irradiations in high flux irradiations. Because of the low-lying resonance peak in the ^{237}Np absorption cross section, variations in neutron temperature have a significant effect on target conversion rates and yields. Results using the BURN and TAIRCOST programs show that the optimum ^{238}Pu production costs are reduced 3 to 4% per 100°C of increased neutron temperature. Work on improving the shielding and in-phantom dose predictions for the LASL-1 sources, on the in-phantom dosimetry measurements of LASL-1 and ^{252}Cf in the Cornell dog-ball and on calorimetric measurements of LASL-1 continued. (T.C.L.)

20949 (ORNL-4533) ORNL ISOTOPIC POWER FUELS QUARTERLY REPORT FOR PERIOD ENDING DECEMBER 31, 1969. Lamb, Eugene (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

All equipment for the Curium Source Test was completed. Equipment assembly and in-cell installation was begun. Fueling of the source is expected to be accomplished in early February. Metallographic examination of $^{244}Cm_2O_3$ compatibility capsules of Ta, Ta – 10% W, T-111, Mo, TZM, W, and W – 26% Re exposed for 5000 hr at 1850°C indicates there has been considerable migration of the fuel inside the capsule. The SNAP-23 generator was shipped. An alternative conceptual design of the SNAP-23 capsule is being developed as the basis for a cost estimate of source fabrication operations. The effect of aging on the impact properties of superalloys is being determined. Hastelloy N and Haynes Developmental alloy No. 188 evaporation rates were measured at 800 to 1050°C and 10^{-9} torr to determine their suitability for use in high vacuum. A joint between platinum and tantalum alloys for extended use in vacuum at elevated temperatures is being developed. (auth)

20950 (ORNL-TM-2910) RADIOISOTOPE PROGRAM (8000) PROGRESS REPORT FOR FEBRUARY 1970. Rupp, A. F. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 28p. Dep. CFSTI.

Efforts devoted to production and distribution of radioisotopes are summarized. Information is included on biomedical radioisotopes, research isotopes, isotopes for power, fission products, radiation source development, applications development, sales, and processing. (J.R.D.)

20951 (ORO-3561-2) PROGRAM TO EXPLORE AND EVALUATE POTENTIAL APPLICATIONS OF RADIOISOTOPE EXCITED X-RAY FLUORESCENCE TECHNIQUES IN CRIMINALISTICS AND NATIONAL SECURITY. Final Report. Sellers, Bach; Hunerwadel, Jean L.; Ziegler, Charles A. (Panametrics, Inc., Waltham, Mass.). 31 May 1969. Contract AT(40-1)-3561. 36p. Dep. CFSTI.

Advances in methods of generating and detecting x-rays, coupled with improvements in miniaturization of electronics, motivated this investigation of the possibility of employing this technology in the areas of criminalistics and national security. Specifically, the advent of radioisotope sources for x-ray generation permit the construction of simple-to-use, compact, portable systems suitable for use in the field by law enforcement personnel. In order to ascertain potential applications a survey involving fourteen government and nongovernment law enforcement and security agencies was carried out. This revealed nineteen problem areas of which eight appeared amenable to solution via the use of x-ray fluorescence methods. Of these, six were selected for further study on the basis of feasibility and the extent of potential use. Based on the results of this study two areas: bullet hole identification and covert marking were designated as first priority applications. Accordingly, prototype models of portable x-ray systems capable of field use were designed, constructed and tested for these two uses. A description of these systems, their theory of operation and directions for their use are given. Recommendations for further implementation of the field testing program are also provided. (auth)

20952 (STI/PUB-246) GUIDE TO THE SAFE DESIGN, CONSTRUCTION AND USE OF RADIOISOTOPIC POWER GENERATORS FOR CERTAIN LAND AND SEA APPLICATIONS. A Report Prepared by a Joint IAEA/ENEA Working Party. Safety Series No. 33. (International Atomic Energy Agency, Vienna (Austria)). 1970. 31p. IAEA $1.50.

A guide is presented which is intended to facilitate the establishment of an adequate standard of safety in the design, construction, installation, use, and ultimate disposal of radioisotopic power generators which have a power output range from about 100 milliwatts to some hundred watts and which are designed for use on land and on or under the sea. Miniature generators for medical use, watches, etc., and generators for use in space were excluded. Two appendices are included which describe recommended fuel capsule and fuel capsule housing tests, adapted from IAEA transport regulations, which would ensure the safety of radioisotopic generators under accident conditions, and therefore, provide a margin of safety in relation to normal operating conditions. (L.C.L.)

20953 ASPETTI TECNICO-PROCEDURALI DELLA SICUREZZA NUCLEARE E DELLA PROTEZIONE SANITARIA PER GLI IMPIANTI DI POTENZA E PER GLI IMPIEGHI INDUSTRIALI DEI RADIOISOTOPI. ATTI DEL XIII CONGRESSO NUCLEARE DI ROMA, 28–29 MARZO 1968. (Aspects of Technological Procedures on Nuclear Radiation Protection and Dose Control of Industrial Uses of Radioisotopes. Proceedings of the XIII Nuclear Conference, Rome, March 28–29, 1968). Serie Simposi. Roma; Comitato Nazionale Energia Nucleare (1968). 384p. (In several languages). (CONF-680330).

Twenty-one papers on the radiation protection and dose control aspects of industrial uses of radioisotopes are included. Separate abstracts were prepared for each. (L.C.L.)

For abstracts of individual papers see: 20954–20959, 20971, 22242, 22362–22370, and 22434–22437.

20954 NON-TECHNICAL CONDITIONS FOR USES OF RADIATION AND RADIOISOTOPES. Proepsti, Georg (EURATOM, Brussels). pp 231-42 of Aspetti Tecnico-Procedurali della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

Just as the biological development depends on conditions of a non-biological order, the development of any technique is affected in a decisive manner by non-technical conditions. The techniques of irradiations and isotopes are classified into four groups (radiometric techniques, irradiation techniques, nuclear reaction techniques, and nuclear techniques for indicators) and each is briefly described. The non-technical conditions include the industry of the non-energy nuclear applications, industrial undertaking of the selling of such services, training of specialized personnel, publication of nuclear techniques, and the legislative framework and administrative standards. Each is considered as it affects the use of irradiations and radioisotopes. Improvement of the conditions foreign to the technique is also discussed. (J.S.R.)

20955 PROSPECTS FOR GROWING USES OF RADIOISOTOPES IN MANUFACTURING INDUSTRIES. Masi, Oscar (Centro Sperimentale Metallurgico, Rome). pp 243-57 of Aspetti Tecnico-Pro-

cedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The marginal effects of Euratom on the introduction of radioisotopes in manufacturing industries are indicated by its low budgetary status. In countries such as Italy in which there are national organizations devoted to this purpose, the prospects for increasing uses of radioisotopes are large. The increase in the industrial use of ^{60}Co, ^{137}Cs, and ^{192}Ir since 1963 is illustrated. The metallurgical industry of Italy makes the most extensive use of radioisotopes. The textile and paper industries are also large users of radioisotopes. The recent legislation and additional needed legislation to promote the industrial uses of radioisotopes are indicated. (J.S.R.)

20956 PROBLEMS OF THE PRODUCTION AND UTILIZATION OF RADIOISOTOPES LEADING TO SOME ASPECTS OF SURVEILLANCE. Todisco, S.; Scassellati, G. A. (SORIN, Saluggia, Italy). pp 259-74 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

A brief, but complete as possible, panoramic view is given of the objective technical aspects of monitoring. These include the basic characteristics of the radioactive material, maximum permissible limits, measurement and control methods, and development of the monitoring system. The procedural aspects of radiation monitoring in the production and utilization of radioisotopes are then described. (J.S.R.)

20957 SUPERVISION OF INDUSTRIAL APPLICATIONS OF RADIOELEMENTS: REGULATORY ASPECTS. Michon, Georges (CEA, Gif-sur-Yvette, France). pp 275-82 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In French).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The general laws of France concerning the protection against radiation are reviewed. The laws with specific application to radioelements are then discussed. (J.S.R.)

20958 CONTROL AND INSPECTION OF THE INDUSTRIAL USES OF RADIOISOTOPES WITHIN THE UNITED KINGDOM. Jones, Brian Ernest (Ministry of Health and Medical Research Council, London). pp 283-95 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The regulations, agencies, activities, procedures, and problems associated with the control and inspection of industrial uses of radioisotopes within the United Kingdom are described. (L.C.L.)

20959 METHODS OF PREVENTION AND PROCEDURES OF CONTROL IN THE USES OF RADIOISOTOPES. Perini, Aulo; Prozzo, Ennio (Ministero del Lavoro e della Previdenza Sociale, Rome). pp 297-305 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The procedures and methods currently used to prevent the exposure of personnel working with radioisotopes in Italy are briefly summarized. (J.S.R.)

20960 INDUSTRIAL APPLICATION OF LARGER RADIATION SOURCES. Wiesner, L. Atomwirt., Atomtech.; 15: 26-28(Jan 1970). (In German).

Based on the symposium for radiation procedures in the plastic industry held at Pullman, Washington and the IAEO meeting on industrial radiation procedures and radiation sources held in Munich, Germany, a summary of the most important processes is compiled. Especially considered are the impregnation of wood by monomers with subsequent radiation polymerization; hardening of varnish on wooden surfaces by radiation exposure; and polymerization of various plastics. Radiation sources, such as accelerators, ^{60}Co, ^{137}Cs, and ^{90}Sr, are discussed. (H.B.G.)

20961 CONCEPTUAL DESIGN OF A 5-kW RADIOISOTOPE-FUELED POWER SYSTEM FOR TERRESTRIAL APPLICATIONS. Calvert, Floyd Olan. Norman, Okla.; Univ. of Oklahoma (1969). 167p.

Thesis.

Within the next decade there is likely to be an increasing need for small power systems in the size range from about three to twenty-five kilowatts. Such systems are currently being developed and applied in space applications. Terrestrial applications will include those serving various categories of underseas missions and also as power source for possible remote installations in the Arctic and Antarctic. The small power size needed for such applications is generally considered to be too small for application of nuclear reactor power systems and too large for economically sound application of thermoelectric or thermionic systems. This conceptual design study initially examines various possible dynamic power conversion systems including Brayton, Rankine, Stirling, and Feher power cycles. The direct Rankine cycle is selected for the design study on the basis of the pertinent criteria. Next considered are various possible working fluids for the power cycle. Steam and mercury are determined to be the best working fluids and power cycles are compared using these two fluids. Even though liquid metals are handicapped in terrestrial applications due to high condensing temperatures it is shown that the liquid mercury cycle may be expected to have as high (or higher) a cycle efficiency as the steam cycle. This is due to the fact that the adiabatic expansion efficiency of the mercury turbine is greater than that for small steam turbine. The radioisotope heat source sub-system design is considered in some detail and a particular cylindrical geometric arrangement using tungsten metal in the dual role of radiation shield and thermal conductor is recommended. The shield is cooled by the working fluid flowing through tubes surrounding the heat source shield. Cobalt-60 is selected as the radioisotope energy source for the power cycle. A direct cycle, liquid mercury Rankine power system is recommended for further design development and optimization. The system would use a multi-stage, single disk, high speed turbine direct connected to the electrical generator. (Disser. Abstr.)

Materials Testing

Refer also to abstract 21363.

20962 FATIGUE DETERMINATION BY RADIOACTIVE GAS. Figueroa, Carlos G. (to Industrial Nucleonics Corp.). U. S. Patent 3,499,319. 10 Mar 1970. Filed 13 Jan 1967.

Incipient fatigue, prior to failure, as a function of changes in crystal structure is determined by incorporating a radioisotope of an inert, rare gas interstitially into the part being tested before or after application of load. Changes in residual radioactivity or increased absorption indicate changes in crystal structure and identify areas of incipient fatigue prior to failure of the part. (Offic. Gaz.)

Protective Structures

Refer also to abstracts 20940 and 20942.

Radioactive Material Handling

Refer also to abstracts 20848, 20934, 20953, and 20956–20959.

20963 (CEA-CONF-1412) INTERVENTION IN A HIGH-ACTIVITY CELL WITH THE AID OF A HEAVY TELEMANIPULATOR. Calame-Longjean, Andre (Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule). [nd]. 28p. (In French). (CONF-691008-8). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

A detailed description is given of the different phases and methods for the partial changing of a fission product concentration evaporator and to improve some parts of the chemical installation in one of the high-activity cells of the Marcoule pilot plant for the processing of irradiated fuel elements. The cell, its equipment, and the telemanipulator used are described. Corrosion of a stainless steel intake valve necessitated the repairs. The methods used for the internal decontamination of the cell are described chronologically. The efficiency of the decontamination is evaluated. The telemanipulation techniques used during the repairs are discussed. The operation was costly in terms of integrated doses for personnel, decontaminstion of the cell, and maintenance of the inter-

vention apparatus. The experiences gained in this repair may make it possible to reduce these costs in other events. Specific suggestions are made. (J.S.R.)

20964 (CEA-CONF-1421) MAINTENANCE OF VENTILATION INSTALLATIONS; INFLUENCE OF THE MEANS OF REGULATION (GATE VALVES, DAMPERS, PIPES) AND OPENINGS, AIR LOCKS, ETC... ON THE DISPERSION OF THE CONTAMINATION. EXPERIENCE ACQUIRED IN THE FIELD IN THE VARIOUS INSTALLATIONS. Salle, R.; Conrad, H.; Quilichini, A. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). [nd]. 21p. (In French). (SM-125/11; CONF-691008-14). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of Hot Facilities, Saclay, France.

Several cases of effective or potential contamination are described and the means for correcting the faults observed in the CEA installations are indicated. These faults included: mistakes in the design of the motor-driven ventilator controls which permitted reversing the air circulation direction between various locations; pressure differences in branches of the ventilating system, which varied with the output, and could reverse the direction of air circulation; bad selection of ventilators used simultaneously in parallel, which could cause overpressure of the installation in case of partial motor failure; heat releases in a high activity cell, thereby expelling the contaminated air to the opening of a roof plate; loss of efficiency of filters caused by a shunting leak; passage of air between two groups of locations ventilated by different ventilation installations; gel or frosting of the external air intakes which results in low pressures in the ventilated locations; and danger of recycling by a chimney receiving the air extracted by several independent ventilation systems. (tr-auth)

20965 (CEA-CONF-1425) TECHNIQUES AND MEANS TO PUT INTO ACTION AT C.E.N. FOR DISMANTLING OF HIGH-ACTIVITY CELLS AND IN-SHOP DECONTAMINATION OF THEIR EQUIPMENT. Bourdrez, J.; Marque, Y.; Roger, B.; Bertrand, E.; Peronnet, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 27p. (In French). (CONF-691008-7; SM-125/18). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

The high-activity cells at the C.E.N. over the course of years have needed repair and remodeling. Their total or partial dismantling requires particular techniques adapted to the evaluated risks of irradiation and contamination. The general principles observed for the dismantling of the high-activity cells are reported. The methods used to verify some previously drawn conclusions are then reviewed on the basis of specific examples. The installation and methods used in the workshop for receiving and processing a large part of the contaminated materials from the high-activity cells are described. The installations consist principally of a shielded cell designed for pre-decontamination of dismantling of contaminated equipment of large dimensions. There is also a large room adapted for work in protective clothing. The equipment used for the protection and monitoring of the operators are reviewed. The results obtained during ten months of operation are reviewed and evaluated. (tr-auth)

20966 (CEA-CONF-1428) PREVENTION AND FIGHTING OF FIRES IN VERY-HIGH-ACTIVITY CELLS. Roussel, E.; Mansard, B.; Mangeot, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 23p. (In French). (SM-12520; CONF-691008-13). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

The origin of fires in very high activity cells can be very varied and some of these are listed as examples. In the design of the cells, prevention of fires is first considered in the selection of construction materials, and then in the installation of fire detectors and fire fighting equipment. The detection methods used in the cells themselves and below the cell filters are outlined. The fire fighting methods consist of extinction products used in the cells, particular arrangements of the cells and extraction circuits, insulation devices mounted on the extraction circuits, use of special containers, and periodic retraining of the laboratory personnel. Each of these is described. The procedure followed after the detection of a fire at various locations in the cell is given. A periodic testing of the installations is made to ensure their reliability. The emphasis in fire fighting is its containment within the cell so that no contamination outside of the hot cell occurs. (J.S.R.)

20967 (CEA-CONF-1429) POLICY OF C.E.A. IN MATTERS OF DESIGN, MANAGEMENT, AND SECURITY OF INSTALLATIONS OF HIGH ACTIVITY. Mas, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nuclearies). [nd]. 29p. (In French). (SM-125/49; CONF-691008-12). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

For each of the various categories of hot installations in France, an outline is given of the evolution of the ideas adopted for the construction of these C.E.A. installations. The French conception of the security of personnel, particularly in the case of hot installations, is then examined. The principles, methods, and procedures which have been satisfactory and which can be adopted for future installations are reviewed. (J.S.R.)

20968 (KFK-666) TRANSPORTATION OF IRRADIATED FUEL ELEMENTS FROM FAST BREEDER REACTORS. Boehme, G.; Gast, K.; Gupta, D.; Hagen, A.; Kraemer, R.; Schikarski, W.; Schmidt, W.; Sebold, G.; Wiese, H. W.; Zimmermann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Nov 1969. 184p. (In German). Dep. CFSTI (U. S. Sales Only).

A comparison of the activity and heating of irradiated fuel elements from fast breeder and light water reactors during transport, shows that an extensive study is necessary of the safety precautions, the engineering problems such as criticality safety, gamma and neutron shielding, cooling, and accident safety in order to design the optimum transport container for the fuel elements. Safety questions are considered, and then the selection of the coolant and construction materials is discussed. The effect of the fuel element and reactor design data in fast breeders is investigated. Engineering problems e.g., heat transfer, gamma shielding, neutron shielding, criticality, and accident results, are considered in detail. Transportation costs are discussed. Optimization of transportation is considered. Typical container designs are reported. The results of a literature search on the design of transport containers for fuel elements from fast breeder reactors are given. (J.S.R.)

20969 (NUS-TM-S-60) EFFECTS OF NUCLEAR POWER STATION LIQUID WASTE DISCHARGES ON LAKE MICHIGAN. Stigall, G. E. (NUS Corp., Washington, D. C.). [1967]. 17p.

For Commonwealth Edison Co., Chicago, Ill.

An increasing number of nuclear power stations have been announced for location along the shores of Lake Michigan, which, by 1975, would have an installed electric generating capacity of almost 8 million kW. A study was made of the effects on the lake of this projected level of nuclear generating capacity discharging both circulating water and radioactive wastes to Lake Michigan. Three types of effects were considered and are discussed: local effects of waste releases; the total assimilative capacity of the lake considering waste injections from a number of sources located along the shores; and the accumulation of discharged radioisotopes on bottom sediments and the potential public health hazard from this accumulation. The study results indicate that: no significant local interaction problems exist; if all units installed along the lake were to discharge at the maximum permissible concentration (which is at least 1 order of magnitude above present practice) it would require an increase of at least a factor of 20 in generating capacity over that presently projected by 1975 for waters of the lake to approach permissible concentrations; this installed capacity of approximately 150,000 megawatts would require over 100 years to reach the equilibrium value; an improvement in the general lake quality leading to an increase in desirable fish population could lead to a reduction in the supportable generating capacity due to reconcentration factors; and accumulation on bottom sediments of radionuclides released from these plants should not provide a limiting source of radiation exposure to the general public. (L.C.L.)

20970 TRU SHIPPING CARRIER (19 Feb 1969) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1979). 16 drawings.

This shipping container is a 66 in. dia spherical stainless steel cask, which weighs 23,500 lbs and is shielded with Blackburn limonite concrete. The cask is fabricated of 1½ in. thick stainless steel and is mounted on a hexagonal stainless steel base. Eight one in. thick ribs are equally spaced at 45° intervals around the upper part of the sphere. Each rib has a 4 in. dia hole which is used in lifting. The cask is transported by special motor trailer. In transport, a tamperproof wire and seal are used to prevent inadvertent opening. The cask carries 1½ in. dia sources in a vertical cylindrical space 3 in. in dia by 6 in. high. The cask can accommodate up to 50g of certain radionuclides including any radioisotope of Am, Bk, Cm, Es, or Fe as a metal, oxide, dried chloride or nitrate except for the following, which are limited to 10g per container: ^{242}Am, ^{249}Cf, ^{251}Cf, ^{245}Cm, and ^{247}Cm. (For details see TID-4100 Suppl. 58.) (F.S.)

20971 THE FUNCTION OF CNEN IN THE GRANTING OF AUTHORIZATION AND SUPERVISION IN THE USES OF RADIOISOTOPES. Failla, Lidia (CNEN, Rome). pp 307-17 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Im-

pieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The legislation giving the CNEN the authority for granting the use of and supervision in the use of radioisotopes is summarized. Some of the specific articles cited are analyzed. The supervisory role of the CNEN is outlined. (J.S.R.)

20972 EARTHQUAKE AT GIZA. Novick, Sheldon. Environment; 12: 2-15(Jan-Feb 1970).

The criteria for selecting the Hanford Reservation as the site of the plutonium production plants are discussed. It is believed that the geological safety of the site selection was hurriedly overlooked in the beginning and the facts are now being presented. A geological report shows that the Hanford facilities are in an area of moderate earthquake action, heavily marked with faults, in which an earthquake might possibly occur directly beneath or near the plutonium-production plants or waste-storage facilities. The magnitude of the radioactivity in the storage tanks at the site is given. A meeting with Dr. Seaborg and geologists is reported and the answers contradict facts reported in the paper. The waste stored at Hanford, if released into air, the Columbia River, and the Pacific Ocean would constitute a nuclear disaster. (J.C.W.)

20973 RECOVERY AND STORAGE OF RADIOACTIVE WASTE IN THE SURROUNDINGS OF MOSCOW. Hirling, Jozsef. Energ. Atomtech.; 22: 487-94(Oct 1969). (In Hungarian).

Before establishing and organizing its work on radioactive waste disposal in Hungary, a literature survey of the experiences of the Soviet Union gained in this field was made. The activity of such establishments near Moscow was studied recently by a group of interested specialists. The work reported is based on personal experiences and gives a survey describing the processes and equipment necessary for treatment and long time storage. (auth)

20974 FISSILE MATERIAL CONTROL IN KARLSRUHE. Gupta, D. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 35-41(Jan 1970). (In German).

Based on the nuclear non-proliferation treaty, the rights of an international control commission to inspect the use of fissile material in commercial nuclear installations were discussed. A system for the control of fissile material was developed and tested at the nuclear center Karlsruhe. From the experimental results, it was concluded that only minor modifications are necessary to make an existing commercial power plant conform to international inspection standards. Five tables, three diagrams, and three pictures are included. (H.B.G.)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstract 22146.

20975 (AD-697921) PROGRESS REPORT [ON] PROBLEM H01-32: AIRBORNE RADIAC, JANUARY 1, 1969-JUNE 30, 1969. Peters, Charles W. (Naval Research Lab., Washington, D. C.). Oct 1969. 23p. (NRL-MR-2056). CFSTI.

The preliminary design of an airborne radiation detector for use in an Airborne Radiac-Flyable Breadboard to measure the ground level dose rate over a fallout field after the fallout cloud has passed is described. Detailed computer calculations support the gamma ray spectral intensity versus altitude characteristics estimated in the previous progress report. (auth) (USGRDR)

20976 (AE-378) THE WHOLE-BODY MONITOR HUGO II AT STUDSVIK. DESIGN AND OPERATION. Devell, L.; Nilsson, I.; Venner, L. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jan 1970. 27p. Dep. CFSTI (U. S. Sales Only).

The whole body monitor laboratory at Studsvik is presented with special attention to descriptions of localities, equipment, calibration and types of measurements. The main monitor, shielded by 53 tons of iron, is equipped with a 8 in. diam. × 4 in. NaI(Tl) detector and a 512-channel Nuclear Data analyzer and located at ground level in the Health and Safety Laboratory a few hundred meters from the various laboratories and reactors at Studsvik. Since the start in June 1963 and up to January 1969 more than 4500 measurements have been performed, most of them for radiation dose control purposes. In about 40% of these latter measurements, internal contamination exceeding the normal detection limit of a few nCi has been observed. Only a few cases so far have exceeded the maximum permissible quarterly dose set by ICRP. (auth)

20977 (ANL-Trans-819) FAST FISSION IONIZATION CHAMBER. Kononov, V. N.; Metlev, A. A.; Poletaev, E. D.; Prokopets, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated for Argonne National Lab., Ill., from report FEI-143. 10p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 45511. (W.H.K.)

20978 (BNL-14168) Si(Li) COAXIAL DETECTORS. Kraner, H. W.; Boulin, C. A.; Wagner, S. (Brookhaven National Lab., Upton, N. Y.). [1969]. 12p. (CONF-700301-3). Dep. CFSTI.

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

Lithium drifted silicon coaxial detectors have been fabricated from 19 mm diameter material with volumes up to 5 cm^3. The double escape peak is observed for gamma rays interacting by pair production. Resolutions (FWHM) of 5 keV and approximately 10 keV have been observed for incident gamma rays of 2.62 and 7.64 MeV. Slices, 2 to 3 mm thick, have been taken from such coaxial detectors and used as low capacity, high resolution X-ray detectors. A FWHM of 300 eV has been obtained at 6.4 keV using a detector with an active area slightly greater than 200 mm^2. (auth)

20979 (BNL-14487) AMPLITUDE DISTRIBUTIONS OF THE POISSON PROCESS TRANSFORMED BY SYSTEMS WITH MEMORY, WITH SPECIAL REFERENCE TO SHOT NOISE AND PILE-UP. Soucek, B.; Cimerman, M.; Breyer, B. (Brookhaven National Lab., Upton, N. Y. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)). [1969]. 17p. (CONF-700301-5). Dep. CFSTI.

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

Many physical and biological phenomena can be described by a transformation of the Poisson process. Such processes have been simulated by the computer for various amplitude distributions and response functions which are common for processing of signals from nuclear detectors. The following amplitude distributions have been analyzed: delta functions, gaussian, exponential, rectangular, and typical nuclear spectra. The system impulse response functions can have arbitrary shapes, such as exponential, RC integrated and/or differentiated, cusp, bipolar, etc. The following cases have been analyzed: continuous time series; pulsed time series (pulsed accelerator case); pulse shaping networks for minimal distortions at high rates; pile-up rejection systems; shot noise; systems with finite resolving time. A large number of cases have been simulated and systematically investigated, and probability density functions for each case are shown. (auth)

20980 (BNWL-946) FFTF STATE-OF-THE-ART REPORT FOR LOW-LEVEL NEUTRON FLUX INSTRUMENTATION. Jackson, C. N. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1969. Contract AT(45-1)-1830. 21p. Dep. CFSTI.

Topics briefly discussed include fuel element failure detection by delayed neutron monitoring, neutron detectors, and low-level neutron flux instrumentation. (W.H.K.)

20981 (CEA-R-3938) PROPORTIONAL COUNTER FOR NUCLEAR SPECTROMETRY BETWEEN 0 AND 100 keV. STUDY OF ^{241}Pu AND ^{249}Bk. CONVERSION ELECTRONS OF HEAVY ELEMENTS. Grenier, Jeanine; Le Du, Rene; Miltenberger, Bernard (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Feb 1970. 18p. (In French). Dep. CFSTI (U. S. Sales Only).

A 2π proportional counter, suitable for the spectrometry of soft β and X radiations ($E \leq 100$ keV) is described. An original field tube arrangement is used to reduce the background in the energy range 0-100 keV. The β spectra of ^{241}Pu ($E_{max} \sim 20$ keV) and ^{249}Bk ($E_{max} \sim 100$ keV) are studied, and the corresponding Kurie plots are in good agreement with the results obtained with magnetic spectrometers. The internal conversion electrons of the soft gamma radiations of ^{237}Pu are also studied. (France)

20982 USE OF A SCINTILLATION DETECTOR ON A GEC-AEI MS 5 MASS SPECTROMETER. Roberts, J. W. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Mass Spectrom. Ion Phys.; 3: 407-9(Dec 1969).

The performance of a Daly type scintillation detector which has been in regular use in the integrating mode on a GEC-AEI MS 5 mass spectrometer for three years is discussed. It has been observed that the gain of the system decreases slightly with use and that there is a deterioration in the shape of the peak tops. These defects have been overcome by replacing the scintillator and recoating the electrode regularly every six months. (M.C.G.)

20983 LIQUID SCINTILLATION COUNTER HAVING MEANS FOR REMOVING ELECTROSTATIC CHARGES ON SAMPLES. Smith, Roy E.; Gullett, Robert C. (to Packard Instrument Co., Inc.). U. S. Patent 3,487,219. 30 Dec 1969. Filed 11 Apr 1966.

A liquid scintillation counting apparatus is provided with means for removing electrostatic charges on sample containers. To remove such charges, the containers are contacted with a volatile polar liquid. (Offic. Gaz.)

20984 LIQUID SCINITLLATION COUNTING STANDARDIZATION. Frank, Richard B. (to Nuclear Chicago Corp.). U. S. Patent 3,500,447. 10 Mar 1970. Filed 11 Apr 1966.

Counting-efficiency correction or standardization measurements on liquid scintillation samples are made by use of an external standardization source placed beneath and closely adjacent to the central portion of each sample. The problem of inaccuracy due to inexactness of the level of filling, inexactness of the positioning, and similar variations in successive sample vials are greatly reduced as compared with other source placements. An automatic liquid scintillation system employing this location of an external-standardization gamma-ray source is described. (Offic. Gaz.)

20985 DEFECT STUDY AND IDENTIFICATION IN Ge(Li) P-N JUNCTION RADIATION DETECTORS. Armantrout, Guy A. (Univ. of California, Livermore). Met. Trans.; 1: 659-65(Mar 1970).

Ge(Li) detectors, which are very high resolution γ-ray spectrometers, are extremely sensitive to defects in the junction of detector. These defects act as charge-trapping centers and seriously degrade the detector performance. Several techniques, which include the detector monochromatic infrared response, reverse current characteristics, and performance analysis, have been used to study these defects. The results indicate that degradation of the detector spectrum is due both to detector inhomogeneities and traps. The main inhomogeneity is caused by a localized variation in the precipitation rate of lithium, which results in weak detector collection fields and heavier localized trapping. The properties of copper, nickel, and iron as traps indicate that the presence of lithium modifies the trap behavior by shielding the Coulomb force and by shifting the deep-trap energy states. The most important traps are those due to lithium effects. The precipitate phase of lithium behaves as a hole trap with a distributed energy level system. A separate lithium phase involving the complex formation of lithium with thermal defects results in an electron trap with an energy position located at $E_c - E_t = 0.22$ eV. (auth)

20986 SEMICONDUCTOR DEVICE FOR DETECTING AND/OR MEASURING RADIATION. Hornstra, J.; Van Dantzig, R.; Oosthoek, D. P. (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 833,192. 27 Jan 1970.

Particularly designed for energetic charged particles, the device consists of a single crystal disc of semiconductor material of diamond structure with the two opposite major surfaces provided with electrodes. One of these is connected to a rectifying junction characterized in that the normal to the disc is oriented in an irrational direction which deviates by an angle of 1° from the [432]-direction of the single crystal towards the [111]-direction. The maximum deviation around the irrational direction is 5°. (Canada)

20987 INVESTIGATION OF PARAMETERS AT LIQUID SCINTILLATION COUNTING. Kaczmarczyk, N. (Technische Hochschule, Munich). Atompraxis; 16: 11-15((Jan-Feb 1970). (In German).

Three parameters (temperature, volume, and settings of gain and discriminator) which influence the counting efficiency, are investigated and optimized. The summarized results are: (1) The counting efficiency increases approximately linearly with decreasing temperature in the range from +20°C to -25°C; thereby the percentage of increase in the counting efficiency is the greater, the stronger the samples are quenched. (2) The volume of the scintillator solution, to which belongs the highest counting efficiency, increases with rising quantity of the quencher; this is explained by the quencher dilution. (3) For higher activated samples the windowless setting is more accurate than the balance point operation, because the windowless measurement supplies greater counting rates. (auth)

20988 DIREC. MEASUREMENT OF RADIOACTIVITY CONTENTS IN RADIOACTIVE SELFLUMINOUS PAINT WHICH IS USED FOR WATCHES AND CLOCKS PAINTED ON THE PLATE. Murayama, Yoshihiko (Nemoto Tokushukagaku Co., Tokyo); Naba, Katsumi. Hoken Butsuri; 4: 587-93(Dec 1969). (In Japanese).

In 1967, a recommendation of IAEA, concerning radiation protection standards for radioluminous timepieces was issued. Accordingly a checking method become necessary to control the radioactivity which is used for the timepiece. After studying the method of direct measurement, the following conclusions were reached. I. The method of measurement for Pm-147 radioactive selfluminous paint. (1) To convert all beta emission of bremsstrahlung, samples were covered with acryl resin plate, thickness 1 mm, (2) Measurement of bremsstrahlung was made by wide end-window GM tubes (3 mg/cm^2, 50 mm dia). (3) To eliminate the geometrical effect, the GM tube was set at 10 cm from the source and the measurable area was restricted to under a 60 mm diameter. (4) The cpm of samples were compared with cpm of standard Pm-147 radioactive selfluminous paint which was measured by the same method. As a result, the method used was able to achieve an accuracy under the error of 10%. II. The method of measurement for H-3 radioactive selfluminous paint. (1) Total luminosity of H-3 radioactive paint was measured by a photomultiplier tube. (2) To eliminate the geometrical effect, the height of the PM from the source was fixed at 25 mm and the measurable area was restricted under 25 mm diameter. (3) The luminosity of samples was compared with the standard H-3 radioactive selfluminous paint which was the similar product, and its decay of luminosity was well controlled. As a result, the error of this measurement was about 10%. (auth) (NSA of Japan)

20989 STUDY ON THE MEASURING METHOD OF SKIN CONTAMINATION BY Pu COMPOUNDS, USING MULTI-HOLE-COLLIMATOR FOR α-RAY DETECTION. Ito, Susumu; Hongo, Syozo (National Inst. of Radiological Sciences, Chiba, Japan). Hoken Butsuri; 4: 581-6(Dec 1969). (In Japanese).

Theoretical and experimental studies on the multi-hole collimator for α-ray detection are described. By using the collimator of Lucite of 2 mm thickness having a great number of holes of 0.5 mm diameter directly in front of the scintillation detector, it is possible to measure α-rays passing through the absorbent layer up to 95% of its range (about 40 μ in tissue) with constant efficiency of 0.3%. In addition, by measuring the α-ray spectrum, it is possible to determine the distribution in depth of the source material. The resolution in this case is about 5% of the range of α-rays (about 2 μ) in full width at half maximum. The measuring efficiency of the multi-hole collimator, the resolution for the distribution of thickness in absorbent layers, and the maximum thickness in which constant efficiency for measuring is obtained are analyzed and solved theoretical as a function of variables determined by the ratio of the diameter of the hole and the thickness of the collimator, and were identified in experiments with good agreement. The less the ratio of the diameter of hole and the thickness of the collimator becomes, the longer the maximum allowable absorbent layer for counting with constant efficiency becomes, and the better the resolution becomes, but less efficiency in measuring is obtained. (auth) (NSA of Japan)

20990 DEVICE FOR CALIBRATING FOILS FOR IRRADIATION. Hachiya, Yuuki (to Nippon Electric Co.). Japanese Patent 1969-22952. 27 Sep 1969. Filed 23 Oct 1965.

The device proposed concerns the calibration of foils when a number of such foils are irradiated for measuring neutron flux and its distribution. The calibration is performed for the difference in material, density, volume, etc., of foils. The device, essentially for irradiating foils in a nuclear reactor, has the advantages of small space requirements, e.g., the possibility of inserting it in an experimental hole, and easy installation and removal. A flanged cylindrical body is installed through the top grid-plate of a core tank. Two pulleys are fixed at the top and the bottom of the supporters, and a belt runs on the pulleys. Irradiation foils are set on the belt at intervals along the length of the belt. The upper pulley and the belt are driven by a suitable driving device for irradiation. The whole device is mounted on the flanged cylindrical body. (NSA of Japan)

20991 SHORT-CIRCUIT OPERATION OF NUCLEAR RADIATION SEMICONDUCTOR DETECTORS. Poenaru, D. Electrotechnica (Bucharest); 17: No. 5, 193-6(1969). (In Rumanian).

A method is presented for determining the shape of current pulses supplied by radiation semiconductor detectors operated in short-circuit conditions. (auth) (Rom. Sci. Abstr.)

20992 IMPROVEMENTS RELATING TO SYSTEMS AND METHODS FOR RADIATION LEVEL AND DISTRIBUTION MEASUREMENT. Townshend, Kenneth Napier; Aggett, Donald John (to Elliott Brothers). British Patent 1,181,788. 18 Feb 1970. Filed 8 Sep 1966.

A radiation level and distribution measurement system for a nuclear reactor is described which employs activable pellets, together with first and second storage means and transfer means. The transfer means is operable to transfer the pellets from the first to the second storage, to transfer pellets from the second storage to the reactor and to transfer the irradiated pellets from the reactor through the second to the first storage means. The transfer means includes a device to control the rate of flow of pellets between the storages, and radiation detection means are mounted in the path of pellet movement between the first and second storages, to measure the radiation level of the pellets before and after irradiation. Gas pressure may be used to drive the pellets. The pellets may comprise steel balls and the radiation detection means may comprise an ion chamber. (UK)

20993 ON THE APPLICATION OF SOME CRITERIA FOR RELIABILITY OF THE RESULTS OF LOW-LEVEL ACTIVITY MEASUREMENTS. Dimchev, T.; Marinov, V.; Vrigazov, A. Isotopenpraxis; 5: 439-44(1969). (In Russian).

The results of applying some criteria for estimation of reliability of low-level ^{90}Sr activity determinations (order of magnitude of 10^{-12} Ci) are given. Radiochemically determined ^{90}Y from milk sols has been measured with a new, original apparatus for low-level measurements. Scintillation counters with thin plastic scintillators in anticoincidence circuit have been used. Measurements are made in 4π geometry. Accuracy, reproducibility, and reliability of the results of radiochemical determination and physical measurement have been studied for various levels of activity. In the range investigated, additivity of errors of the determination has been stated. The mean reliability was 93.8 per cent based on analysis and measurement of standard samples of recommended activity determined in three laboratories of the USAEC. (auth)

20994 MEASUREMENT OF CONVERSION COEFFICIENTS WITH A Ge(Li) DIODE. Baldinger, E.; Haller, E. (Univ., Basel). Helv. Phys. Acta; 42: 949-56(30 Dec 1969). (In German).

High resolution Ge(Li)-detectors were used to register simultaneously gammas and conversion electrons of nuclear transitions. Registration with arbitrarily narrow window can be achieved by direct irradiation of the intrinsic volume of the diode. Good agreement of the internal conversion coefficients α_K of 570 keV-^{207}Pb, 1064 keV-^{207}Pb and 662 keV-^{137}Ba transitions with previous measurements has been found. The corresponding relative coefficients α_K/α_L and α_K/α_{M+N} do not appear to be published as yet and consequently only the values obtained at this laboratory are presented. The accuracy of the method is limited by the error in the full energy peak efficiency of the Ge(Li) detector and is in our experiments about 10% for α_K and <10% for the α_K/α_L and α_K/α_{M+N}. The simple experimental arrangement and the rapidity with which results can be obtained give this method considerable

preference. On the other hand irradiation into the intrinsic zone may imply difficulties concerning the surface treatment. (auth)

20995 UNIT FOR THE WHOLE-BODY RADIOMETRY. Vanin, V. Ya.; Gerasimova, M. P.; Stolyarov, V. P. (Inst. of Biophysics, Moscow). Med. Radiol.; 15: No. 1, 60-7(Jan 1970). (In Russian).

Parameters of a spectrometer at different stages of its exploitation designed at the Institute of Biophysics for measuring radiation emitted in man and consisting of a detector with a NaI(Tl) crystal and a protective steel chamber are presented. Spectrometric resolution of the unit for the 662 keV γ-line for a fantom filled with a ^{137}Cs solution and a NaY(TE) crystal of 203 mm diameter and 102 mm high was 10.4%. During a 15-minute measurement, the sensitivity of the spectrometer enables it to determine the presence of 0.6×10^{-9} C of Cs in the organism with an accuracy better than 68%. Parameters of whole-body counters now employed in the USSR are cited. (auth)

20996 POSITION SENSITIVE COUNTER TELESCOPE FOR THE STUDY OF NEUTRON INDUCED REACTIONS. Valkovic, V.; Kovacevic, K.; Vidic, S. (Inst. Ruder Boskovic, Zagreb). Nucl. Instrum. Methods; 79: 13-18(1970).

A counter telescope with improved angular resolution for the study of angular distributions of charged particles from neutron induced reactions has been described. Further improvements are suggested. (auth)

20997 MONTE CARLO CALCULATIONS OF GAMMA RAY RESPONSE CHARACTERISTICS OF CYLINDRICAL Ge(Li) DETECTORS. Lal, B.; Iyengar, K. V. K. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods; 79: 19-28(1970).

Monte Carlo calculations have been made to compute the full energy peak efficiencies and the double escape peak efficiencies for right circular cylindrical Ge(Li) detectors for point gamma-ray sources. The full energy peak efficiencies are calculated in the gamma-ray energy range from 100 keV to 2.5 MeV and the double escape peak efficiencies are calculated in the range from 1.7 MeV to 4.0 MeV. All calculations have been made for source to detector distance of 5 cm. Various detector sizes have been considered with surface area varying from 2.5 cm^2 to 8.0 cm^2 and the thickness varying from 2 to 10 mm. The results are compared with the calculations of earlier workers and also with some of the experimental investigations. A code "MONTCARL" has been developed for this purpose in FORTRAN language for the CDC 3600 computer. The same code can be used to calculate the response function of the detector to gamma-rays. One such calculation has been made for monoenergetic gamma-rays and it compares very well with the experimental results. (auth)

20998 INSENSITIVE ZONES IN THE INTRINSIC REGION OF Ge(Li) COAXIAL DETECTORS. Cappellani, F.; Ostidich, A.; Restelli, G. (CCR-EURATOM, Ispra, Italy). Nucl. Instrum. Methods; 79: 170-4(1970).

Insensitive regions in the intrinsic volume of a double open ended coaxial Ge(Li) detector have been put in evidence and evaluated by using the gamma ray scanning technique with photons of different energy. Insensitive zones have been observed at both open ends of the diode, having circular geometry with a thickness increasing from the p core to the n^+ electrode. Their size is sensitive to the detector bias and can be reduced by a suitable warm-up and by redrift cycles. Their existence is probably related to local imperfect compensation of the Li drifted germanium. (auth)

20999 FADING OF RELATIVISTIC TRACKS IN K-5 NUCLEAR EMULSION AT HIGH TEMPERATURE. Friedlaender, E. M. (Inst. for Atomic Physics, Bucharest); Friedlaender, J.; Marin, A.; Settles, R. D. Nucl. Instrum. Methods; 79: 165-9(1970).

Evolution in time of the latent image fading of relativistic tracks in K-5 emulsions is investigated at a temperature typical of exposures in high intensity pulsed magnetic fields. The fading is significantly non-exponential and strong enough to cause systematic shifts and relatively wide scatters of the estimated track parameters. Plates subjected to preheating show a more regular and hence predictable fading behaviour, as well as a weaker overall fading. (auth)

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Refer also to abstracts 21955, 22033, and 22445.

21000 (JINR-P13-4899) ERROR DUE TO PULSE PILING-UP IN THE MEASUREMENTS OF AMPLITUDE SPECTRA AND ERROR DIMINISHING BY MEANS OF PILE-UP INSPECTORS (REVIEW). Semenov, B. Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 31p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Some general problems concerning the error due to pile-up effects and the method for diminishing it are discussed. The methods of determining pile-up effects and the devices used in such cases (pile-up inspectors) are considered. It is shown that inspectors investigating time intervals between two pulses offer good possibilities. The inspectors are classified and their specifications and performance are considered. It is shown that for the spectrometric system with pulse shaping in RC-filters the spectrometer inhibiting time with the inspector should be in logarithmic dependence upon the analyzing signal amplitude. (auth)

21001 (NP-18194) SELECTIVE DETECTION OF GASEOUS FISSION PRODUCTS. Bouville, Andre (Toulouse Univ. (France)). 1970. 238p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

After a bibliographical review on the detection of fission gases, a selective detection method of these fission gases having a radioactive decay chain is developed. Two types of detectors are used: a NaI(Tl) spectrometer for low activities and a Ge(Li) diode for higher activities. Two experimental devices are realized. In Toulouse, a sub-critical device producing fission gases is developed. In Saclay, experiments are carried out at EL 2 and Ulysse on fission gases with half-lives lying between 2.8 hours and 3 min (^{88}Kr, ^{138}Xe, ^{89}Kr), betwenn 3 min and 5 s (^{90}Kr, ^{139}Xe, ^{91}Kr, ^{140}Xe) and between 5 s and 1 s (^{92}Kr, ^{141}Xe, ^{142}Xe). Detection is made selective by the proper choice of the working conditions of the installation and by the use of a γ spectrometer. The disintegration levels of the measured daughter products are studied and the cumulative fission yield of the gases calculated. (auth)

21002 (ORNL-tr-1871) RAPID PULSE-HEIGHT DISCRIMINATOR WITH COMPENSATION OF THE TIME OF RISE AND THE THRESHOLD EFFECT. Jung, H.; Bruellmann, M.; Meier, D. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Nucl. Instrum. Methods; 55: 301-22(1967). 31p. Dep. CFSTI.

A pulse-height discriminator is described which electronically effects a compensation for the time dispersion. It is designed for pulses which have a common rise-time T_R between 0.5 and 5 ns. The discriminator threshold can be set to any desired height from 1.6 V to over 5 V. The threshold width is below 50 mV. For pulses with $T_R - 5$ ns, the maximum time dispersion lies below 50 ps for amplitude variations between 0 and 15 V and frequency variations between 0 and 100 kHz. The discriminator was designed for a fast neutron time-of-flight spectrometer, with a view to reducing the line broadening caused by the continuous pulse-height spectrum of the neutron detector. The spectrometer, based on the associated-particle technique, is briefly described. The full width at half height of the coincident neutron spectrum is smaller than 0.7 ns for a scintillator thickness $d \approx 1$ cm, and is virtually independent of the threshold energy. (auth)

21003 ORANGE TYPE SIX-GAP MAGNETIC BETA SPECTROMETER AT SWIERK AND ITS APPLICATIONS IN COINCIDENCE MEASUREMENTS. Preibisz, Zygmunt; Kurcewicz, Wiktor; Zglinski, Antoni (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 14: 743-60(Aug 1969).

The construction and adjustment of a six-gap toroidal magnetic spectrometer at Swierk is presented and some examples of its application in electron-gamma coincidence measurements are discussed. The possible resolution settings of the spectrometer are between 0.4% and 2%, and the corresponding transmission values are between 0.3% and 9%. For the detection of gamma rays NaI(Tl) or Ge(Li) crystals are used. A standard fast-slow coincidence circuit with a time-to-amplitude converter is applied. The instrument has been used mainly for the investigation of complex decay schemes of deformed nuclei. (auth)

21004 DIFFRACTION NEUTRON MONOCHROMATOR (17 Oct 1968) (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1978).

10 drawings.

A crystal monochromator, used for studies of the (n,γ) reaction, provides a neutron beam with a full duty cycle at a given energy. Advantages of the monochromator include small target size, large geometrical efficiency of γ ray detection, and negligible fast neutron background. The useful energy range extends from 0.01 to 20 eV. Precision angle encoders are used for setting arm and crystal angles. A liquid shield, consisting of a 37% solution of anhydrous borax in ethylene glycol, facilitates the extraction of the diffracted neutron beam. Air bearings provide for the motion of the target, detection devices, and associated shielding. In the operation of the apparatus, the primary neutron beam passes through a collimator

seven ft long and one in. wide with a vertical aperture which tapers outward so that the full 3½ in. height of the beam thimble in the reactor may be viewed. The beam converges to a height of one in. at the target. A second collimator which has a slightly greater angular aperture, is contained in an Al housing which also holds the liquid shielding. At the crystal, the primary beam intensity is 10^9 n/cm² sec and the beam current is 2×10^{10} n/sec. At the target position, the diffracted beam current is $\sim 2 \times 10^5$ sec at 1 eV. A small direct beam of one cm dia is also available and is filtered through a 15 in. of crystalline quartz. Beam intensity is 7×10^7 n/cm² sec and the Cd ratio is 2×10^4. (For details see TID-4100 Suppl. 58.) (F.S.)

21005 A DOUBLE MAGNETIC COINCIDENCE BETA-RAY SPECTROMETER OF THE GERHOLM TYPE. Lizurej, Henryk I. (Jagellonian Univ., Krakow); Niewodniczanski, Henryk. Nukleonika; 14: 761-76(Aug 1969).

A description of a double magnetic beta-ray spectrometer of the Gerholm type, and its design, adjustment and calibration, and the application of this instrument in measurements of the excited states of nuclei are discussed. The resolution of the spectrometer for a source 2 mm in diameter and transmission of 3 per cent is 1.5 per cent. The maximum source diameter used in the spectrometer is 8 mm. Stabilized current supplies permit focusing of electrons of energies from 20 keV to 2.9 MeV. (auth)

21006 LINEAR VECTOR SPACE THEORY OF UNFOLDING. Karayianis, N.; Morrison, C. A.; Wortman, D. E. (Harry Diamond Labs., Washington, D. C.). Nucl. Sci. Eng.; 40: 38-50(Apr 1970).

The general problem of unfolding is considered from the point of view of linear vector space theory as applied to the more specific problem of spectral unfolding. It is shown that the basis for many of the methods currently in use is an expansion of the unknown spectrum $\varphi(E)$ in terms of some set of functions $w_n(E)$. The coefficients in the expansion are determined by the measured outputs of the detectors. The relationships between the various solutions obtained by using different sets of $w_n(E)$ functions are explored. It is shown that the particular solution obtained by using the response functions of the detectors as the $w_n(E)$ is effectively an orthogonal decomposition of $\varphi(E)$ whereas all other expansions are nonorthogonal decompositions. As a result of these properties, the response function expansion, for example, has a bounded square deviation from $\varphi(E)$ and is less sensitive to errors in the measured detector outputs, whereas other expansions can lead to solutions that may differ violently from $\varphi(E)$. Conditions under which the latter situation can occur are of a fundamental nature and do not owe their origin to calculational inaccuracies. The square-wave solution is given particular attention and the theoretical basis is investigated of the standard practice of requiring an all positive solution with theoretical outputs that differ least from those measured. It is shown that the correct square-wave representation for $\varphi(E)$ results in theoretical detector outputs that necessarily differ from those produced by $\varphi(E)$ itself—possibly by a large amount. Thus, except for cases where this difference is known, a priori, to be small, there is no theoretical basis for this standard practice. (auth)

21007 COORDINATE PROPORTIONAL COUNTER. Biryukov, V. A.; Zinov, V. G.; Konin, A. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 58: 104-7(Jan 1970). (In Russian).

Results are presented of investigation of a 30×30 cm² multiwire proportional counter suitable for measuring the coordinates of the site of flight of a charged particle. (auth)

21008 IMPROVED MEDICAL SPECTROMETER. Satterfield, M. M.; Dyer, G. R.; Ross, D. A.; McClain, W. J. (Oak Ridge National Lab., Tenn.). J. Nucl. Med.; 11: 158-64(Apr 1970).

A flexible, modularly designed pulse-height spectrometer now under field test is described. Although planned primarily for the field of nuclear medicine, this unit may be used in other scintillation spectrometry applications. Designed for use with a sodium iodide detector, the instrument covers an energy range from a few keV to several MeV. The linear amplifier, with continuously variable gain from 30 to above 3,000, is linear to an output voltage of 10 volts, and may be operated in either single- or double-differentiating modes. The base line is stable at high counting rates, and pole-zero compensation provides good overload performance. The pulse-height discriminator uses a zero-crossover design with a window opening of up to 30% of the base level. A scaler-timer section provides preset time intervals from 0.1 to 200 min in convenient steps; it also provides preset counts ranging from 500 to 40,000 with the elapsed time displayed in steps of 0.01 min. A solid-state, series-regulated supply provides high voltage for the photomultiplier tube, maintained to within 0.002% throughout a line-voltage range of 90 to 140 volts. The long-time drift is less than 0.025%/hr. (auth)

21009 STATISTICAL DETERMINATIONS OF HALF-LIVES. Foglio Para, A.; Bettoni, M. Mandelli (Politecnico, Milan). Nucl. Instrum. Methods; 79: 125-8(1970).

The half-life of the ground state of ^{114}In has been evaluated by statistical methods. The procedure is based on the deviation from the Poisson statistics of the counts due to the radiation of a two-step cascade. After a development of the pertinent theory, the experimental results are presented, which lead to a $t_{\frac{1}{2}}$ determination in agreement with the literature value. (auth)

21010 EXPERIMENTAL DETERMINATION OF THE SLOW-NEUTRON WAVELENGTH DISTRIBUTION. Lebech, B.; Mikke, K.; Sledziewska-Blocka, D. (Danish Atomic Energy Commission, Risoe, Denmark). Nucl. Instrum. Methods; 79: 51-4(1970).

Different experiments for determining the slow-neutron wavelength distribution in the region 3 to 227 MeV have been carried out, and the results compared. It is concluded that the slow-neutron wave-length distribution can be determined accurately by elastic scattering on a pure incoherent or a pure coherent scatterer. (auth)

21011 RAPID ESTIMATION OF COMPONENT-SEPARATION IN PARTLY RESOLVED DOUBLETS, PARTICULARLY IN MOESSBAUER SPECTROMETRY. Moon, P. B. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 79: 61-4(1970).

The combined profile of a close doublet of lines shows the peaks closer than their true separation because of the gradient of either profile at the center of the other. If the components are individually symmetrical and equally intense, the necessary correction of observed-to-true separation can readily be made in terms of the ratio of the observed maximum intensity to that of the central minimum. An alternative method, generally to be preferred, gives the true separation in terms of the same ratio and of the separation between points on the combined profile where the intensity is equal to that at the centre. Both methods can also be applied to absorption lines that are not too intense and both are fairly insensitive to line shape, and to inequality of intensity of the components. (auth)

21012 BIAS IN A LEAST SQUARE METHOD OF ANALYSING DECAY DATA. Robinson, D. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods; 79: 65-8(1970).

The very common method of analysing decay curves by fitting a straight line to the logarithm of the decay curve using the reciprocals of the number of counts per channel as weights, has been found to introduce an error of the order of 0.5% in the lifetime. The dependence of this error on the number of counts accumulated, the number of half-lives analysed and the background can be described by an empirical formula. For accurate results it is better to use an iterative procedure to fit an exponential to the counts observed, using the numbers produced by the fit as weights instead of the actual counts. (auth)

21013 A LOW BACKGROUND TELESCOPIC SYSTEM FOR THE STUDY OF (n,α) REACTIONS. Ajdacic, V. (Inst. Boris Kidric, Belgrade); Chatterjee, M. L.; Cindro, N.; Jurcevic, M. Nucl. Instrum. Methods; 79: 77-81(1970).

The time-of-flight technique involving the associated alpha particles from the 14 MeV neutron producing T(d,n)^{4}He reaction has been used to minimize the background of a telescopic system consisting of two hydrogen filled proportional counters and a silicon detector. This technique has been employed for the study of the ^{16}O(n,α)^{13}C reaction which has a Q value of −2.2 MeV. The energy spectra obtained and the angular distribution are in good agreement with recent measurements of Bissem et al., who used a CsI(Tl) detector. The silicon counter background is appreciably reduced by this technique, which can be conveniently utilized for the study of negative Q value (n,α) reactions having differential cross sections down to about 1 mb/sr. (auth)

High Energy Physics Instrumentation

Refer also to abstract 21955.

21014 (BNL-14466) PARTICLE IDENTIFICATION AT RELATIVISTIC ENERGIES BY THE USE OF SECONDARY EMITTERS. Llacer, J. (Brookhaven National Lab., Upton, N. Y.). [1970]. 21p. (CONF-700301-4). Dep. CFSTI.

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The usefulness of negative-electron-affinity secondary emitters as detectors of particles in the high relativistic region is studied theoretically in detail. It is found that GaP(Cs) has poor secondary escape statistics, resulting in the inability to distinguish between 200 GeV/c protons and pions in single particle experiments. GaAs (Cs + [O_2 + Cs]) has good escape statistics, but its active depth may

be too large, and density effects are expected to set in. A $GaP_{(1-x)}$–GaAs heterojunction which could solve both problems is discussed. In any case, it is found that nonlinear filtering of the near Landau distributed signals from secondary emitters is required in order to obtain useful particle discrimination. One feasible scheme is proposed which should allow separating 200 GeV/c protons and pions, for example, with 90% efficiency or better at near 100% confidence. (auth)

21015 (IS–2230) KERTRAN COMPILING SYSTEM. Cate, C. L.; Higby, W. J.; Wagstaff, R. L. (Ames Lab., Iowa). Dec 1969. Contract W-7405-eng-82. 70p. Dep. CFSTI.

An analysis of the KERTRAN language translator that operates in conjunction with the on-line measuring system for bubble chamber film data at Iowa State University is presented. Included is a discussion of programming considerations in designing a translator and of the methods by which these problems were resolved in the KERTRAN compiler. A detailed discussion of the major elements of the compiler, namely the instruction types, the name table, and the instruction table, is given; and an analysis of future improvements is made. Short descriptions of each of the KERTRAN routines, program listings, and flowcharts of the major routines are given. (auth)

21016 STUDY OF THE EFFECT OF ULTRASONIC VIBRATIONS ON THE FORMATION OF HIGH-ENERGY PARTICLE TRACKS IN A LIQUID-HYDROGEN BUBBLE CHAMBER. Akulichev, V. A.; Gavrilov, L. R.; Grebinnik, V. G.; Zhukov, V. G.; Libman, G.; Manych, A. P.; Rudin, Yu. I.; Rozenberg, L. D.; Selivanov, G. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR; 189: 973-5(11 Dec 1969). (In Russian).

Studies were carried out on a 25 cm liquid-hydrogen bubble chamber in which was placed a receiver and an ultrasonic vibrator of barium titanate emitting energy at a resonance frequency (corresponding to a zero mode of oscillation) of 14.0 kilocycles/sec. The unit was placed in a beam of 340 MeV π^- mesons with passage of the particles through the chamber being synchronized with the ultrasonic vibration by turning on the expansion system and by photographing the working volume of the chamber. By working with a magnetic field of 2.5 kilooersteds, a temperature of 27°K and an expansion decreased by a factor of 2 from the usual one, it was possible to obtain clear tracks of negative pions from the synchrocyclotron. The use of a focusing system with the ultrasonic emitter created waves of high acoustic pressure in the liquid, and decreased the parasitic boiling. The results indicate that in theory it is possible to replace the expansion system of a bubble chamber by an ultrasonic vibrator. (TTT)

21017 IDENTIFICATION OF HIGH ENERGY PARTICLES IN A STREAMER CHAMBER. Davidenko, V. A.; Dolgoshein, B. A.; Somov, S. V.; Starosel'tsev, V. N. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz.; 58: 130-2(Jan 1970). (In Russian).

Relativistic growth of the specific primary ionization is measured in the following mixtures: 50 torrs Ne + 50 torrs He + 2 torrs H_2O and 320 torrs Ne + 320 torrs He. The accuracy of the measurements is 2.5%. The possibility of employing a streamer chamber for separation with respect to mass of particles with momenta up to 200 GeV/c is discussed. (auth)

21018 SCINTILLATION COUNTER ARRAY FOR DETECTION OF HIGH ENERGY NEUTRONS. Parsons, A. S. L. (Univ. of California, Berkeley); Truoel, P.; Berardo, P. A.; Haddock, R. P.; Verhey, L.; Zeller, M. E. Nucl. Instrum. Methods; 79: 43-50 (1970).

An array of 32 liquid scintillation counters used to detect neutrons in the energy range 20 to 340 MeV is described. Each unit consisted of a cylinder 45 cm long and 7 cm diameter, with the axis of the cylinder parallel to the incident neutron direction. The array was calibrated in the above energy range by use of neutron-proton elastic scattering. The average efficiency was 0.45. Some secondary properties of the array have been studied and are described. (auth)

21019 HODOSCOPE OF SILICON SURFACE BARRIER DETECTORS FOR LOW ENERGY PION PHOTOPRODUCTION EXPERIMENTS. Bateman, J. E.; Hogg, W. R. (Univ. of Glasgow). Nucl. Instrum. Methods; 79: 134-40(1970).

The detection of recoil charged particles from reactions produced by 300 MeV bremsstrahlung on light nuclei has been carried out using a hodoscope of totally depleted multi-element silicon surface barrier detectors. A large effective detection solid angle and a wide angular range have been achieved with good angular resolution. The charged particles were identified using the silicon range-energy relation technique. The development of the multi-element detectors and the experimental properties of the hodoscope are described. (auth)

21020 COMPTON POLARIMETER FOR 2-MeV BREMSSTRAHLUNG. Rank, D.; Unfried, E. (Oesterreichische Hochschule, Vienna). Z. Phys.; 233: 231-9(1970). (In German).

A polarimeter for bremsstrahlung must simultaneously perform two functions: it must select photons within a small energy interval out of the continuous bremsstrahlung spectrum and it must measure the polarization of these photons. The polarimeter depends on the polarization sensitivity of the Compton process with a 5 mm Si(Li-drift) detector as scatterer and a plastic scintillator as photon detector. To improve the energy resolution of the polarimeter a second 0,5 mm Si(Li-drift) detector behind the scatterer is placed in anticoincidence with the scatterer. (auth)

21021 A STUDY ON BUBBLE FORMATION IN THE BUBBLE CHAMBER. Poesposoetjipto, F. H.; Hugentobler, E. (Univ., Fribourg, Switzerland). Helv. Phys. Acta; 43: 203-22(Apr 1970).

An experimental study on bubble formation was performed using a temperature- and pressure-stabilized bubble chamber. The bubble formation by high-energy ionizing particles was studied for $CBrF_3$ at 25.9, 28.8, and 32.4°C. Furthermore, the bubble formation by α-decay recoils was investigated for $CBrF_3$, CCl_2F_2, and C_3F_8 in the temperature range 20 to 60°C. It was found qualitatively that from both experiments the energy needed for the bubble formation should be deposited in a volume of subcritical dimension. Light-induced bubble formation was observed and the results are described. (auth)

Radiation Dosimeters

21022 (CEA-CONF–1444) TEST OF SEVERAL TECHNIQUES APPLICABLE TO MICRODOSIMETRY OF CHARGED PARTICLES. Parmentier, N. C.; Chemtob, M.; Chmelevsky, D. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Chianelli, J. C. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 20p. (In French). (CONF-691012–2). Dep. CFSTI (U. S. Sales Only).

From 2nd Symposium on Microdosimetry, Ispra, Italy.

It was established that each time it is necessary to explain the action of radiations on the biological medium, it was necessary to reduce the scale examined. The present study has the object of predicting in the microscopic volumes the form of the energies dissipated. The experimental difficulties of detection in thin solid media do not permit, in the present state of the technique, operation on very thin surfaces nor on dissipated energies below several tens of keV. Design is proceding on a wall-less spherical proportional counter which it is hoped will make it possible to descend to equivalent-tissue thickness and to measure dissipated energies at least equal to 30 eV by profiting from the multiplication. (tr-auth)

21023 (HASL–219) THERMOLUMINESCENCE SPECTRUM AND THE ENERGY CONVERSION EFFICIENCY OF LITHIUM FLUORIDE. Strash, Alfred M. (Clarkson Coll. of Tech., Potsdam, N. Y. Dept. of Physics). 15 May 1969. Contract AT(30-1)-3646. 132p. Dep. CFSTI.

Thesis.

Harshaw TLD-100 and Harshaw TLD-600 thermoluminescence spectra are given for samples irradiated with 85 MeV protons and for samples irradiated with cobalt-60 gamma rays. The spectra appear to exhibit structure in the wavelength region around 5500 Å. The proton irradiations include doses of 110, 564, 1120 and 11,200 rads in TLD-600 and an irradiation of 588 rads in TLD-100. Also, TLD-100 and TLD-600 were irradiated to 500 rads by gamma rays. Prior to irradiation in each case, the samples were given an annealing treatment of one hour at 400°C followed by 24 hours at 80°C. The samples had no prior irradiation history. Following irradiation the samples were heated to 100°C for 15 minutes. Glow curves of 30 milligram samples of the irradiated material were recorded at wavelength intervals of 100 Å in the region from about 2500 Å to 6000 Å. The thermoluminescence emission is proportional to the differential (in wavelength) efficiency. Typical values of the total efficiency of the phosphors ranged from 0.10% to 0.15%. A relation to express the efficiency in the supralinear region has been determined. It has been found that the efficiency increases in the supralinear region as $\ln(D/D_0)^n$, where D is the absorbed dose, D_0 is the dose at the beginning of the supralinear region and n is the slope of a plot of ln(D) versus the efficiency in the supralinear region. Typical values are D_0 = 900 rads and n = 0.069 for TLD-600. (W.H.K.)

21024 (HASL–223) NEUTRON DOSE EQUIVALENTS FROM MULTISPHERE ACCELERATOR-SHIELD LEAKAGE SPECTRA. Weinstein, M. S.; Hajnal, F.; McLaughlin, J. E.; O'Brien, K. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Mar 1970. 23p. Dep. CFSTI.

Multisphere spectrometric measurements of accelerator stray neutrons were used in an exploratory study of dose equivalent distributions with neutron energy. Results indicate that a substantial fraction of the dose equivalent from neutrons occurs in the energy range below about 0.4 MeV, the threshold of thin personnel monitoring emulsions. Even above this threshold, the emulsion is required to perform very well as a fast neutron dosimeter to measure the contribution of the neutrons and to account for the major part of the dose equivalent. The results also indicate that representing an accelerator leakage spectrum as a simple energy value to infer dose information may be misleading. It is believed that supplementary measurements, such as with moderating spheres, are almost a necessity. (auth)

21025 (LA-4335) NEUTRON MEASUREMENT USING THERMOLUMINESCENT DOSIMETERS. Engelke, Morris J. (Los Alamos Scientific Lab., N. Mex.). Dec 1969. Contract W-7405-eng-36. 9p. Dep. CFSTI.

A method of determining the average neutron energy and fluence in a radiation field is described. Miniature thermoluminescent dosimeters are employed as detectors embedded in a moderating medium consisting of an 18-in.-diam polyethylene sphere. The equipment, calibration procedures, and results are described. A comparison of experimental measurements to transport theory calculations of sphere-counting efficiencies is made. The approximate average neutron energy can be established easily and quickly in the neutron-energy range from 500 keV to 20 MeV. The practical use and limitations at accelerators where the particle energies are less than 20 MeV are discussed. (auth)

21026 (UCRL-Trans-10430) ADIABATIC γ-CALORIMETER WITH IMPROVED SENSITIVITY. Khol'nova, E. A.; Kul'kova, L. P. Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Livermore, from Symposium on Standardization of Radionuclides, International Atomic Energy Agency, Vienna, October 10-14, 1966. 21p. (CONF-661012-48). Dep. CFSTI.

A discussion is given of the design of an adiabatic gamma-ray calorimeter with improved sensitivity, developed at the D. I. Mendeleev Institute of Metrology (Leningrad); and the results obtained with this device are reviewed. The main part of the calorimeter is a spherical lead absorber, 70 mm in diameter, mounted in a watertight chamber. This chamber is placed at the center of a water-filled thermostat whose temperature rises automatically as the temperature of the calorimeter increases due to the absorption of γ-rays from a source located in the absorber. The sensitivity of the calorimeter is sufficient to measure the activity of ^{60}Co γ-sources from 5 μCi upward, with an accuracy better than 2.5 to 3%. (auth)

21027 CALCIUM SULFATE ACTIVATED BY LEAD AND MANGANESE FOR THERMOLUMINESCENCE DOSIMETRY. Yamashita, Tadaoki; Sakai, Kunio; Kitamura, Saburo (Matsushita Electric Industrial Co. Ltd., Osaka). J. Nucl. Sci. Technol. (Tokyo); 7: 105-10(Feb 1970).

$CaSO_4$: Pb, Mn was found to be free from the serious disadvantage of rapid fading possessed by $CaSO_4$: Mn, the most sensitive thermoluminescence phosphor available so far. A study was made on the effect of Pb and Mn content on $CaSO_4$, and it was concluded that Pb in $CaSO_4$ produces traps for radiation energy, resulting in improvement of the properties of the phosphors for dosimetry. The optimum content of such activator additives was found to be 0.2 mole % of Pb and 3 mole % of Mn. The improved phosphor produces glow peaks at 160 and 190°C, and the energy yield of the thermoluminescence is about 4%, twice that of $CaSO_4$: Mn. The more significant properties of the phosphor from the point of application to radiation dosimetry include: linear response from 50 μR to 10^4 R, minimum detectable dose of 50 μR ± 25%, and a fading rate of 5%/week. (auth)

21028 RESPONSE OF THERMOLUMINESCENT DOSIMETERS TO 15 Mev ELECTRONS AND ^{60}Co GAMMA RAYS. Ehrlich, M. (National Bureau of Standards, Washington, D. C.). Health Phys.; 18: 287-9(Mar 1970).

The relationship between dosimeter response and the energy absorbed in the dosimeter material is of great interest. In the course of some electron dosimetry studies, thermoluminescent dosimeters (LiF, Ca F_2/Mg) were irradiated with 15 MeV electrons in a polystyrene phantom. Similar dosimeters were also exposed to ^{60}Co γ-radiation, for which purpose the TLD material was enclosed in polystyrene of thickness equal to the range of the most energetic Compton electrons produced by the γ-ray photons in the polystyrene. Results showing the relative TL response per unit absorbed dose in the dosimeter material for a number of different absorbed doses are shown in tabular form. For the 15 MeV electrons the absorbed dose was computed from measurements made with a Fricke dosimeter, while for the γ-radiation the absorbed dose was computed from the exposure. Since the range of the Compton electrons produced by the ^{60}Co γ-ray in the dosimeter was comparable to the TLD cavity dimensions, the absorbed dose in the cavity arose not only from the electrons produced in the polystyrene wall but also from the electrons produced in the cavity itself, and consideration is given to this in the calculations, both for small and large cavities. It was found that within the experimental reproducibility of ±5% the relative TL response per unit absorbed dose in the systems studied was the same for ^{60}Co γ-radiation and for 15 MeV electrons, as expected from other studies, and was independent of electron energy. The findings do not contradict the dependence of TLD response on LET. If constancy of TLD response over a wide range of electron energies is assumed it may be calculated that the response per unit absorbed dose in water is ~2% higher for ^{60}Co γ-rays than for 15 MeV electrons for a small LiF cavity. For CaF_2 the corresponding valves for the small and large cavities are 4% and 6%. (UK)

21029 ON THE THERMAL FADING CHARACTERISTICS OF SOME TSEE DOSIMETRY MATERIALS. Becker, K.; Chantanakom, N. (Oak Ridge National Lab., Tenn.). Atompraxis; 16: 31-6(Jan-Feb 1970).

The fading of thermally stimulated exoelectron emission (TSEE) from three ionic crystals of dosimetric interest has been studied as a function of several parameters. In LiF (TSEE peakground 150°C), some fading occurs at room temperature. The fading rate was not affected by the LET of the radiation, humidity, and storage in vacuum. In BeO (lower TSEE peakground 270°C) there appears to be more fading in water vapor than in vacuum and dry air. In $CaSO_4$ (several peaks), the shape of the TSEE glow-curve is dependent on LET as is the fading rate at elevated temperatures. The TSEE curve changes during fading, shallow traps being emptied more rapidly than deep traps. (auth)

21030 THE THERMOLUMINESCENCE OF LiF AND CaF_2: Mn EXPOSED TO PROTONS WITH ENERGIES FROM 5 TO 137 MeV. Parker, Cleofus Varren Jr. Austin, Tex.; Univ. of Texas (1969). 130p.

Thesis.

The thermoluminescence of lithium fluoride and manganese activated calcium fluoride was studied experimentally as a function of exposure to nearly mono-energetic proton beams. Proton beams with average energies of 5 to 137 MeV were obtained from cyclotrons by degrading the primary beam with suitable absorbers. The particle energy, energy spread, fluence, and spatial distribution were experimentally determined. The absorbed dose in the thermoluminescent phosphors was obtained by calculation using these data. The thermoluminescent response per rad for high energy protons was found to be approximately the same as that for ^{60}Co gamma-rays, while intermediate energies of 50 MeV gave a response per rad that was about 15 to 20 percent greater than the gamma-ray response. The response per rad at lower energies decreased significantly, but the finite thickness of the phosphor samples produced large uncertainties in the calculated dose and prevented accurate determinations of the response per rad from being obtained at these lower energies. Energy dependence of the type described was observed for all sample configurations studied. The response as a function of dose at a particular energy was observed to be linear for calcium fluoride for all dose levels and energies investigated. Lithium fluoride had a response which was non-linear at doses greater than a few hundred rad for gamma-rays and high energy protons. The high dose response became more linear as the proton energy was reduced. The state of the theoretical description of thermoluminescence dosimetry was investigated. The microscopic theory of ionization called target theory was applied to the thermoluminescence of these phosphors. Some connections between the mathematical formulation currently in use and the physical processes of ionization and trapping were examined. The current state of the knowledge of thermoluminescent phenomena prevented any unified model from being proposed, but some qualitative explanation of the behavior of the two phosphors was possible based on the target theory concept. (Disser. Abstr.)

21031 X-RAY AND UV DOSIMETRY BY NON-LUMINESCENT SOLID-STATE METHODS. Toole, James Michael. University Park, Pa.; Pennsylvania State Univ. (1969). 79p.

Thesis.

A dosimetric procedure is described which makes use of the pyroelectric properties of a material. Single crystals of ZnS (wurtzite) and tourmaline (green variety) are used as dosimeters for ultraviolet and x-ray radiation, respectively. The crystals are in the form of platelets with the large area surface normal to the polarization axis. Polarization is produced when the crystal temperature is increased linearly by heating an oil bath in which the crystal has been immersed, or by means of a specially designed test chamber. The measured polarization is governed by the pyroelectric coefficient as well as the internal resistance of the speci-

men. The latter is diminished, in the course of heating, by electrons released from traps previously filled by the incoming radiation. The behavior of the system is analyzed in terms of an equivalent circuit which regards the material as a constant current generator. Comparisons with thermoluminescence and current glow processes are described. ZnS is found to be an extremely sensitive dosimeter for u.v., but has a very limited range and rather poor storage capabilities. Tourmaline on the other hand, as an x-ray dosimeter, is quite insensitive but has extended range and long term storage capabilities. Both materials are similar in their behavior as dosimeters. (Diss. Abstr.)

21032 THERMOLUMINESCENT LITHIUM BORATE. Brunskill, Robert Thompson (to United Kingdom Atomic Energy Authority). British Patent 1,181,507. 18 Feb 1970. Filed 14 Dec 1966.

Lithium borate has been proposed as a possible thermoluminescent material for use in dosimetry due to its good tissue equivalent properties, but suffers from the disadvantage that its sensitivity to β-γ radiation is low compared with LiF. A method is described to provide material of improved sensitivity by doping the tetraborate with Mn, melting the doped borate and resolidifying in an argon atmosphere. Several alternative methods of preparation are described. Comparative glow curves are shown for LiF, commercial lithium-borate and lithium borate prepared as described. A heating temperature range of 150° to 300°C is preferred, and it is advisable to use a photomultiplier tube with good response to orange light. After use, the material may be re-used without further heat treatment. (UK)

Radiometric Instruments

21033 (ORNL-tr-2297) γ-ABSORPTION POROSIMETRIC STUDY OF PORE SIZES OF ARTIFICIALLY DENSIFIED GRAPHITE MODIFIED AS A RESULT OF NATURAL GAS CRACKING. Bochirol, L.; Ortega, M.; Teoule, R. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Carbon; 6: 649-60(1968). 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 9779.

Miscellaneous Instruments and Components

Refer also to abstracts 20982, 21154, 21194, 21435, 22145, and 22423.

21034 (AERE-M-2286) ELECTRICAL CHARACTERISTICS OF HARWELL 7000 SERIES DATAWAY. Multilayer Printed Circuit Board Type 94/40148-6. Hale, F. H.; Thompson, A. N. (Atomic Energy Research Establishment, Harwell (England)). Jan 1970. 9p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

The Harwell Crates types 7005/6 were designed to comply with the CAMAC standard (modular instrumentation system for data handling-Euratom). They incorporate a printed circuit board that interconnects the appropriate pins on twenty-four 86-pin (double sided) edge connector sockets, defined by CAMAC, and pins on a twenty-fifth edge connector, which may be regarded as ancillary to the crate and is not defined by CAMAC. CAMAC compatible units can be plugged into any of the 24 connectors, but will not fit into the additional position associated with the 25th edge connector, the latter being designed to accept special units, such as the 0704-1, which monitors the voltage supplies to the crate. The printed circuit board is multilayered and through-hole plated. The 25 edge connectors can be fitted to it and, by wave soldering, the appropriate pins can be connected to the copper buses, lines and planes provided by the eight layers in the multilayered board. The characteristics measured on the printed circuit board without edge connectors fitted were D. C. resistance, capacitance to earth plane, and losses on power buses. (UK)

21035 (BNWL-1302) EVALUATION OF THE SPERRY ULTRASONIC WHEEL INSPECTION UNIT. Smith, R. W.; Johnson, N. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 58p. Dep. CFSTI.

The Sperry wheel ultrasonic inspection unit, Model 50D467, was evaluated for remote surveillance of the FFTF pressure vessel during reactor shutdown. Facilities for testing transducers and transducer components in the FFTF environment were developed. A number of materials were tested for use in the projected FFTF environment. It was found that the Sperry wheel has three drawbacks which make it unsuitable for use in the FFTF environment. These are: 1) it cannot be used on a dry surface, 2) a number of the components will not tolerate the projected environment, and 3) the acoustic noise level is too high for FFTF surveillance. (auth)

21036 (BRH/DEP-70-3) DESCRIPTION AND EVALUATION OF A FLUOROSCOPIC SCREEN VISUAL BRIGHTNESS COMPARER. Ferguson, John P.; Properzio, William S.; Murphy, Emmet G. (Bureau of Radiological Health, Rockville, Md.); Paul, Ira R. (New York City Dept. of Health, N. Y. Office of Radiation Control). Mar 1970. 45p. CFSTI.

A visual brightness comparator is described for measuring the luminescent response of a fluorescent screen. A fluorescent screen under test and a standard fluorescent screen are irradiated and the light produced is projected by an arrangement of mirrors for visual comparison. Field test data are presented and analyzed. (W.H.K.)

21037 (KFK-929) OPERATION SYSTEM FOR MANY-FOLD ACCESS IN LABORATORY AUTOMATION. Krueger, G. (Kernforschungszentrum, Karlsruhe (West Germany)). Jul 1969. 22p. (In German). Dep. CFSTI (U. S. Sales Only).

In the Karlsruhe Nuclear Research Center the TR 86 A DV system of the Firma AEG-Telefunken was installed for the automation of the laboratory in the varying areas of nuclear physics, nuclear chemistry, and nuclear engineering. The operational program to be developed must serve both as the basis for the fulfillment of the time-critical devices of the real-time data detection and carrying out of the experiments of the directly coupled research installation as well as for a pace-maintaining evaluation controlled by the experimentor from the outside station. The following conditions must be fulfilled: (1) control of the plotting process in the DV installation by data from the outside station. The data originating from the various sources (experimentors, measurement apparatus, and small DV installations) must be treated similarly. In this way a stepwise increase of the degree of automation is possible and a great flexibility is assured; (2) coordination of the various activities by a planning and safety program running the preferable mode. Of great significance for the step-by-step planning is the maintenance of asserted reaction times of the DV system in critical experimental events; (3) dynamic control of the experimental course according to intermediate results in the framework of guide lines previously given by the experimentor; (4) extensive freedom in the planning, programming, and operation of the very differently experimentally oriented programs with suitable control and operation functions. The first version of the operational program is in the test stage. (tr-auth)

21038 (RT/PROT-(69)16) SPECTROMETRY OF X-RAYS EMITTED BY APPARATUSES WITH ACCELERATING VOLTAGE BETWEEN 60 TO 280 kV. Casnati, E.; Fioratti, M. Paganini; Piermattei, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 3 Dec 1968. 33p. Dep. CFSTI (U. S. Sales Only).

Scintillation spectrometry and absorption analysis measurements of the spectral distributions of x rays emitted by two commercial tubes (a beryllium-window self-rectifying tube with peak voltage variable in the range from 5 to 80 kV and a 100 to 300 kV constant potential apparatus) are presented and discussed. The beam collimators, filters, and detector systems are described. (W.H.K.)

21039 (UCRL-72261) LRL WEAPONS TEST PROGRAM COMMUNICATION SYSTEMS. Stefani, R. E. (California Univ., Livermore. Lawrence Radiation Lab.). Jan 1970. 35p. (CONF-700202-1). Dep. CFSTI.

From The AFTRCC Meeting, Las Vegas, Nev.

Two concepts for improving the weapons test facilities at the Nevada Test Site are presented. (1) Provide an RF transmission system that will enable one central controller to perform all the nuclear device orientated functions between it and the device ground zero sites. The new Device Timing and Control (T&C) System will replace the existing hardwire system that operates from several central control points. (2) Provide an RF transmission system for the Nevada Automated Diagnostic (NAD) System. The NAD system concept is to modernize the data acquisition and analysis capabilities presently available at the Nevada Test Site. The RF transmission system will enable one central controller to perform all the diagnostic data oriented functions between it and the acquisition units at the ground zero sites. (W.H.K.)

21040 FAST PULSE HEIGHT ANALYZER. Pozar, F. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Atompraxis; 16: 25-8(Jan-Feb 1970).

A single channel pulse height analyzer having a resolving time of 16 ns is presented. In the second mode the instrument operates as a discriminator with a very small time walk. The circuits are included, and the performance of the instrument is discussed. (auth)

21041 SIMPLE LEVEL CONTROLLING AND AUTOMATIC FILLING SYSTEM FOR LIQUID NITROGEN. Waeppling, R.;

Karlsson, A.; Haeggstroem, L. (Uppsala Univ.). Nucl. Instrum. Methods; 79: 93-4(1970).

The advantages of using a combination of semiconductor diodes and carbon resistors as temperature sensing elements in the liquid nitrogen range are shown and an automatic filling system for liquid nitrogen is described. (auth)

21042 THE MAGNETIC LEVITATION ELECTROMETER AND ITS USE IN THE SEARCH FOR FRACTIONALLY CHARGED PARTICLES. Morpurgo, G.; Gallinaro, G.; Palmieri, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nucl. Instrum. Methods; 79: 95-124(1970).

The operation of the magnetic levitation electrometer both in the static and in the resonance version is described in detail. The sensitivity of the instrument in the resonance version allows measurements of charge to a precision often better than $1/_{20}$ e in grains of matter (graphite) having a mass of the order of 5×10^{-7} g. On a total amount of 3.4×10^{-3} g of pyrolitic graphite explored, corresponding to $\approx 2 \times 10^{18}$ nucleons, no fractionally charged quark has been found. (auth)

21043 STORAGE-CRT INTERACTIVE DISPLAY FOR NUCLEAR PHYSICS COMPUTER SYSTEMS. Blatt, S. L.; D'ippolito, D. A. (Ohio State Univ., Columbus). Nucl. Instrum. Methods; 79: 175-7(1970).

An interactive display system utilizing a storage-type CRT has been developed. It is found to be economical, easy to interface and program, and to provide several advantages over conventional systems. (auth)

Radiation Effects on Instruments and Instrument Components

21044 (ANL-Trans-813) THERMOLUMINESCENCE CHARACTERISTICS OF VARIOUS LITHIUM FLUORIDE CRYSTALS IRRADIATED IN A REACTOR. Lyushina, A. F. Translated for Argonne National Lab., Ill., from Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 5, 36-9(1968). 7p. Dep. CFSTI.

A study was made of the thermoluminescence characteristics of various lithium fluoride crystals exposed to a radiation dose of up to 5×10^{16} n/cm^2 in a vertical beam hole. The possibility of broadening the range of dosimetry by the use of thermoluminescence of LiF crystals is discussed. (auth)

21045 (COO-1624-24) NUCLEAR RADIATION EFFECTS ON SILICON P-N JUNCTIONS. Technical Progress Report. Goben, Charles A. (Missouri Univ., Rolla. Space Sciences Research Center). Feb 1970. Contract AT(11-1)-1624. 26p. Dep. CFSTI.

The dependence of neutron-induced space-region recombination on the electric field strength present in the junction during irradiation has been determined. Surface effects of ionizing radiation have been studied and a scheme for predicting the surface degradation of matched devices has been implemented. The junction capacitance variation with neutron fluence and gamma radiation has been determined. A technique has been developed for determining the net impurity profiles of both neutron irradiated (or gold-doped) and unirradiated devices. One result of this has been the discovery that the out-diffusion of the substrate (or buried layer) is non-negligible and has a significant effect on both the base region and collector junction parameters. A discrete, deterministic mathematical model has been developed for the base region of semiconductor transistors which accounts for both the effects of recombination in the neutral base region and the drift field for graded base devices. This model allows the prediction of transistor characteristics from knowledge of the impurity profile, initial lifetimes, currents, and fluence level to which a device is to be exposed. The effects of fast neutrons on the high frequency characteristics of p-n junction transistors was examined via the scattering parameters. The forward gain of transistors was observed to increase with neutron fluence for devices operating at or above 0.8 f_T. This unexpected result is being examined further. A lumped element transistor model (similar in principle to the Ebers-Moll model) has been developed for use by circuit analysts and designers. It can match device data accurately over six to eight decades of current density and yields such parameters as forward current gain as a function of collector current naturally from the elements without need to resort to the artifice of fitting a polynomial to the data. Thought has been given to implementing an iterative procedure for determining design criteria for radiation tolerance by starting with a trial impurity profile and operating constraints (bias voltages, currents, current gain, limitations of fabrication processes) and repeatedly generating device characteristics for changes in the impurity profile until optimums are achieved. This subject is under careful investigation. (auth)

21046 EFFICIENCY DEGRADATION OF $GaAs_{1-x}P_x$ ELECTROLUMINESCENT DIODES DUE TO HIGH-ENERGY ELECTRON IRRADIATION. Nuese, C. J.; Schade, H.; Herrick, D. (RCA Labs., Princeton, N. J.). Met. Trans.; 1: 587-91(Mar 1970).

The effects of high-energy electron bombardment on the external quantum efficiency of $GaAs_{1-x}P_x$ electroluminescent diodes have been investigated for several alloy compositions x. After the generation of 10^{17} to 10^{18} cm^{-3} defect centers in the junction region by a 1-MeV electron beam, quantum efficiencies are found to degrade by 2 to 4 orders of magnitude. This drastic efficiency reduction is ascribed to the introduction of nonradiative recombination processes. After irradiation, the efficiencies of all diodes are found to have the same value of 7×10^{-8} at 300°K, independent of alloy composition. Furthermore, a similarity in the annealing characteristics of all diodes indicates the presence of the same types of defects throughout the alloy composition range investigated ($0 < x < 0.5$). Irradiation defects are annealed from the $GaAs_{1-x}P_x$ diodes at lower temperatures as the phosphorus content of the alloy is increased. Finally, it is shown that annealing leads to nearly full recovery of the original diode efficiencies. (auth)

21047 RADIATION-HARDENED INTEGRATED CIRCUITS. Kravitz, Bernard L. (Dionics, Inc., Westbury, N. Y.). Solid State Technol.; 13: 57-60(Jan 1970).

The rapidly growing need for radiation-hardened I.C.'s has provided the impetus for solving the extremely difficult process problems in some detail to give the reader an appreciation of their complexity and their subtle interactions. While not completely solved, the problems are being reduced and at least are now more thoroughly understood. After a slow start, the rate of progress is improving markedly. (auth)

21048 DAMAGE COEFFICIENT OF Si N/P SOLAR CELLS IRRADIATED WITH ELECTRONS AND PROTONS. Wohlleben, K. (Forschungslaboratorium, Erlangen, Ger.). Z. Angew. Phys.; 28: 183-9(9 Jan 1970). (In German).

The energy dependence of the damage coefficient K of 0.8-Ωcm-Si-n/p solar cells was investigated for irradiations at electron energies from 0.5 to 2.5 MeV and proton energies from 1 to 3 MeV. The damage coefficient is defined by the change of the inverse square value of the bulk minority carrier diffusion length referred to the particle fluence: $K = d(1/L^2)/d\Phi$. The diffusion length was determined from the short-circuit current of the solar cells during particle irradiation having regard to the inhomogeneous ionisation density. The influence of the inhomogeneous density of the lattice defects along the range of the protons was to a large extent eliminated by pre-irradiation of the cells with electrons. The K-values (referred to 1-Ωcm bulk material) increase steeply with the electron energy (from 3.9×10^{-11} at 0.5 MeV to 1.19×10^{-9} at 2.5 MeV). The damage coefficient and the introduction rate for the K-center in p-type silicon exhibit nearly the same dependence on the electron energy. In the case of proton irradiation, the K-values decrease only slightly as the energy is increased (from 4.5×10^{-6} at 1.0 MeV to 3.3×10^{-6} at 3.0 MeV). (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 20743 and 22145.

Basic Processes

Refer also to abstract 21239.

21049 MOLECULAR HYBRIDIZATION OF RADIOACTIVE DNA TO THE DNA OF CYTOLOGICAL PREPARATIONS. Pardue, Mary Lou; Gall, Joseph G. (Yale Univ., New Haven). Proc. Nat. Acad. Sci. U. S.; 64: 600-4(Oct 1969).

A method is presented for detecting the cellular location of specific DNA fractions. The technique involves the hybridization of a radioactive test DNA in solution to the stationary DNA of a cytological preparation. Sites of DNA binding are then detected by autoradiography. Experiments with DNA of the toad Xenopus are described. (auth)

21050 RADIOIMMUNOASSAY OF GASTRIN. Yalow, Rosalyn S.; Berson, Solomon A. (Veterans Administration Hospital, Bronx, N. Y. Mount Sinai School of Medicine, New York). Gastroenterology; 58: 1-14(Jan 1970).

A highly specific radioimmunoassay for endogenous human plasma gastrin was developed using guinea pig antisera to crude porcine gastrin. Highly purified ^{125}I-porcine gastrin I, further purified on starch gel electrophoresis after labeling, was employed as a tracer, and an anionic exchange resin was used to separate bound and free labeled gastrin. Sensitivity is better than five pg per ml. Cholecystokinin-pancreozymin and amino-terminal and carboxyl-terminal gastrin peptides cross-react only poorly in the gastrin-antigastrin system. Plasma gastrin and standard gastrin show parallel inhibition curves against the labeled porcine gastrin. Reproducibility of determinations in different assays is demonstrated. Plasma gastrin is unaffected by boiling for five to 10 min. High values of plasma gastrin were observed in five patients with Zollinger–Ellison syndrome and in 17 patients with pernicious anemia. Administration of HCl per os or into the stomach in five patients with pernicious anemia produced an acute fall in plasma gastrin concentration; the half-time for disappearance of gastrin from plasma was as short as seven min. (auth)

21051 EFFICACY OF COBALT PELLETS FOR PROVIDING COBALT FOR PENNED SHEEP. Dewey, D. W.; Lee, H. J.; Marston, H. R. (Commonwealth Scientific and Industrial Research Organization, Adelaide). Aust. J. Agr. Res. 20: 1109-16(Nov 1969).

Cobalt pellets introduced into the rumens of sheep, either singly or accompanied by an abrasive steel grinder or by a second pellet, have been shown to be equally as effective, over a period of more than 5 years, as a supplement of 1 mg Co/day per os in maintaining health, body weight, and adequate concentrations of vitamin B_{12} in liver and serum of sheep fed on a cobalt-deficient ration in pens. Comparison of the weight losses of pellets recovered from the rumens in which they were carried, either singly or together with another heavy object, and studies with pellets containing ^{60}Co have shown that release of cobalt from a pellet which is accompanied by an abrading device is significantly greater than when a single pellet is carried in the rumen. Increase of the calcium acetate content of the diet increased the rate of release of cobalt from the pellet. (Australia)

21052 STUDIES ON THE SPECIFICITY OF THE RADIOIMMUNOASSAY FOR THE DETERMINATION OF THE LUTEINIZING HORMONE IN BOVINE BLOOD. Schams, Dieter; Karg, Heinrich (Technische Hochschule, Munich). Z. Physiol. Chem.; 351: 41-6(Jan 1970). (In German).

Using the bovine luteinizing hormone (LH), the purity of the antigen LH-LER-791-1 was confirmed by discelectrophoresis and immunelectrophoresis. After absorption of the antisera with bovine serum cross reactions could be observed by immunelectrophoresis and immunodiffusion only with the preparation NIH-TSH-B4, but not with HCG, PMS, and other preparations of anterior pituitary hormones. Corresponding results were obtained by the sensitive radioimmunological investigations, as far as cross reactions could not be considered due to LH-contaminations or (in case of HCG and PMS) occurring only in extremely high dose-ranges, which were not competent for practical measurements. The results of recovery experiments, the parallel shape of dilution curves of added LH compared with standard curves and also the identical behavior of endogenous and standard LH in dilution series showed that the established test is suitable to satisfy essential pretentions of specificity. (auth)

21053 THE RADIOIMMUNOASSAY OF THE LUTEINIZING HORMONE AND OF PROLACTIN. Karg, H.; Schams, D. (Technische Hochschule, Munich). Berlin. Muenchen. Tieraerztl. Wochenschr.; 82: 471-3(Dec 1969). (In German).

The radioimmunoassay of the luteinizing hormone (LH = ICSH) and or prolactin, which could be developed to measure the blood levels in the female bovine, are suitable also for the determination of the hormones in the male bovine. For ICSH, which is responsible for the regulation of the testes function, in young bulls concentrations around 1 ng/ml blood plasma were determined. The prolactin levels varied between 10 to 200 ng/ml. The values obtained from steers were in the mean higher than those from bulls. Mainly the results of prolactin showed high individual and diurnal variations. The physiological importance of this hormone in the male bovine is not yet known. (auth)

21054 A METHOD FOR LOCAL LABELLING OF THE THYMUS AND OF THE BURSA OF FABRICIUS OF THE CHICKEN WITH TRITIATED THYMIDINE. Linna, T. J.; Hemmingsson, E.; Baeck, R. (Univ. of Uppsala). Acta Pathol. Microbiol. Scand.; 77: 557-8(1969).

A functional delineation of the immune system has been demonstrated in the chicken. Humoral immunity has been shown to be dependent on the bursa of Fabricius and cellular immunity has been shown to be mainly under the influence of the thymus. An improved local labeling method for the bursa and a local labeling method for the thymus of chickens of different ages is presented here. These methods can be used to study cell migration from the bursa and the thymus to other organs. (C.O.)

21055 RADIOIMMUNOASSAY OF OVINE THYROTROPIN (OTSH) USING A BOVINE TSH (BTSH) RADIOIMMUNOASSAY SYSTEM. COMPARATIVE EFFECTS OF THYROIDECTOMY AND CASTRATION UPON OVINE PLASMA TSH AND LH. Freychet, P. (Institut National de la Sante et de la Recherche Medicale, Paris); Pelletier, J.; Rosselin, G. Ann. Biol. Anim., Biochim., Biophys.; 9: 483-96(1969). (In French).

The similar behavior of ovine and bovine TSH in the ^{131}I BTSH-anti BTSH system permitted immunoassay of ovine TSH with this system that was sensitive enough to measure plasma TSH in normal ewes and rams. The pattern of cross sections observed in this system with purified ovine LH and FSH as well as effects obtained with plasma from castrated rams, show that ovine gonadotropins interfere per se in the system. However, it was possible to obliterate this cross reactivity by adding ovine LH. This saturation with ovine LH makes bovine TSH system suitable for specific immunoassay of ovine TSH. Thyroidectomy resulted in a rapid increase in plasma TSH of 3 ewes. A 25-fold rise in plasma TSH was observed 3 weeks after thyroidectomy. Following intravenous administration of L-Thyroxine (L-T_4, 2.5 mg per day) to thyroidectomized animals, plasma TSH fell to normal values within 3 to 5 days. Following discontinuation of L-T_4 therapy, plasma TSH levels became elevated in 8 to 10 days, but return to high values similar to those observed before T_4 treatment was hardly achieved 5 to 6 weeks after withdrawal of L-T_4. Plasma LH values remained at normal level during the course of these experiments. While castration resulted in a rapid increase in plasma LH over a 7-day post-operative period, plasma TSH variations did not correlate those of LH. However, a slight increase was observed, which was significant on the 7th day after castration, when the untreated (without OLH) radioimmunoassay system was used. Utilizing the OLH saturated system for plasma samples from castrates gave values which were significantly lower than those obtained with the untreated system. (auth) (C.O.)

21056 SOLID PHASE RADIOIMMUNOASSAY OF HUMAN β 1C GLOBULIN. Askenase, Philip W.; Leonard, Edward J. (National Heart Inst., Bethesda, Md.). Immunochemistry; 7: 29-41(Jan 1970).

In all radioimmunoassays it is necessary to separate free radioactive antigen from that portion bound to antibody. If the antibody is fixed to a solid surface, partition of free and antibody-bound antigen can easily be accomplished by separation of liquid and solid phases. A method of solid phase radioimmunoassay first suggested by Catt and Tregear was studied. It is based on adsorption of antibody to surfaces such as polystyrene test tubes. Three steps are required. The first, adsorption of specific antibody to a

fixed area of polystyrene tube surface, occurs on equilibration of protein solutions in tubes at room temperature and pH 7.4. Adsorption is much greater and more predictable from globulin fractions than from whole antiserum. The second step is prevention of non-specific adsorption of antigen to sites on the tube. This is done by coating antibody tubes with an inert protein that does not interfere with antigen-antibody interaction and by incorporating the same inert protein into antigen solutions. The last step is equilibration of antibody-coated tubes with solutions of labeled antigen and increasing amounts of unlabeled antigen. The solutions are then removed and radioactivity bound to the tube surface is measured to quantify inhibition of labeled antigen uptake by unlabeled antigen. Solid phase immunoassay presents problems because antibody sites are not saturated with antigen in the practical working range. This sets limits on assay sensitivity because of conflicting requirements of high antigen concentration to approach antibody saturation and low labeled antigen for maximal isotope dilution. The requirements can be met by equilibrating tubes with a minimal antigen solution volume. Detection of 7 ng of β 1C globulin has been achieved. Results showed that the immunoassay results can be predicted from isotope dilution of the antigen mixtures if account is taken of the increased antigen binding that occurs as antigen concentration rises. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 21093–21095, 21097, 21104, 21106, 21151, 21156, 21173, 21184, and 21258.

21057 (ANL-Trans-802) TISSUE RADIOACTIVITY OF INHABITANTS OF VARIOUS REGIONS OF THE SOVIET UNION. Pertsov, L. A.; Popov, D. K.; Dzyubenko, I. I.; Ermolaeva-Makovskaya, A. P.; Ostryakova, N. I.; Porova, A. A.; Plotko, E. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated for Argonne National Lab., Ill., from report A-AC-82/G/L-1182. 17p. Dep. CFSTI.

This is an English language translation of a report published originally in Russian. The report was abstracted previously from the original language and appeared in Volume 22 of NSA as abstract 33800. (E.R.B.)

21058 (FOA-4-4405) STUDIES ON PLANT ACCUMULATION OF FISSION PRODUCTS UNDER SWEDISH CONDITIONS. XII. UPTAKE OF ^{137}Cs BY BARLEY AND PEAS FROM 12 DIFFERENT TOP SOILS COMBINED WITH 2 SUBSOILS IN A LONG TERM MICRO PLOT EXPERIMENT. Fredriksson, L.; Loensjoe, H.; Eriksson, A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Nov 1969. 45p. Dep. CFSTI (U. S. Sales Only).

In a long-term microplot experiment, uptake of ^{137}Cs by barley and peas from twelve Swedish arable soils on two different subsoil types was studied. The uptake of ^{137}Cs in the crops was largely dependent on the content of clay and organic matter in the soil. Decreasing content of clay and increasing content of organic matter in the soil both enhanced the ^{137}Cs uptake in the crops. Therefore, the ^{137}Cs content in barley seed varied between 10 and 150 pCi per kg dry matter at a deposition in the soil of 1 Ci ^{137}Cs per sq.km. The ^{137}Cs content in peas was about 5 times higher. The experiments also showed that on subsoils easily accessible to the plant roots the uptake of ^{137}Cs from the plough layer soil may be about one third less than on subsoils less accessible to plant roots. When more potassium was taken away with the crops than was added by fertilizers, the ^{137}Cs uptake increased from year to year although the trend was occasionally influenced by the annual variations in the weather conditions, which caused variations in the root activity at different depths in the soil profile. (auth) (Sweden)

21059 (UCB-34-P-113-5) RADIOTRACER STUDIES ON THE MECHANISM OF INSECTICIDAL TOXICITY. Triennial Progress Report, January 1, 1967–December 31, 1969. Casida, John E. (California Univ., Berkeley. Div. of Entomology). 24 Dec 1969. Contract AT(11-1)-34. 94p. Dep. CFSTI.

The research effort in 1967, 1968, and 1969 was devoted primarily to the elucidation of the metabolic fate, photochemistry, and mode of action of a variety of insecticide chemicals and their synergists, and it generated much useful data importantly related to the acceptance and use of chemicals for insect control. Included was work designed to generate fundamental degradation- and structure-activity data pertinent to the chemicals of interest, basic data on the binding characteristics of some of them at the active sites on important enzymes, and fundamental information on the mechanism and biochemical genetics of resistance development in houseflies to insecticide chemicals. In 1969, work was initiated on the role photosensitizers play in the photoalteration of insecticide chemicals, on the nature of the insect neuromusçular mediator substance, and on the degradation of juvenoids. Radiotracers played an important role in these investigations and their use often was the only practical approach available, being indispensable in binding-site explorations and uniquely helpful in studying cleavage of molecules. This approach entailed synthesis of carbon-14 and/or tritium-labeled preparations of many key compounds. More sophisticated approaches to the problem of analysis and characterization of degradation products were developed. (auth)

21060 (UCRL-50781) INCORPORATION OF TRITIUM FROM TRITIATED WATER INTO CARBOHYDRATES, LIPIDS, AND NUCLEIC ACIDS. Smith, Thomas E.; Taylor, Robert T. (California Univ., Livermore. Lawrence Radiation Lab.). 26 Nov 1969. 24p. Dep. CFSTI.

A literature survey of reactions involved in some of the major pathways of carbohydrate metabolism in mammals reveals that in tritiated water at least seven of the reactions of the glycolytic scheme would be expected to incorporate tritium into stable carbon-hydrogen bonds in intermediary products. Some of the products would eventually lead to the biosynthesis of lipids, proteins, and into the one-carbon units. In a similar manner, other protein constituents, coenzymes, and prosthetic groups such as porphyrins would become labeled with tritium through the reactions of the tricarboxylic acid cycle. Examination of the reactions involved in the oxidative and nonoxidative pathways for ribose 5-phosphate formation shows that in tritiated water these two pathways would yield ribose 5-phosphate with a stable tritium atom in all five positions, but the ribose would be more heavily labeled in positions 3, 4, and 5. Deoxyribose formed by the ribonucleotide reductase system would retain all of the originally incorporated tritium and would add another tritium atom by the direct replacement of a hydride ion (that is completely exchangeable with the medium) from the enzyme into position 2 of the deoxyribose. Similarly the literature clearly indicates that in mammalian tissues, as well as bacteria, one-carbon unit metabolism will contribute tritium to the cellular lipid and nucleic acid constituents. The central metabolite involved in one-carbon metabolism is $N^{5,10}$-methylenetetrahydrofolate, which drives its methylene group from the β-carbon atom of serine. The methylene bridge group retains both of the hydrogen atoms of the β-carbon of serine and, consequently, will contain tritium. This tritium will then be incorporated into the methyl group of S-adenosyl-L-methionine, the methyl group of deoxythymidylate, and the C-2 and C-8 positions of the purine bases. Additional tritium will appear in the C-5 methyl group of thymidylate due to the cyclic reduction of dihydrofolate back to tetrahydrofolate. The specific enzymatic steps involved in the divergent metabolism of $N^{5,10}$-methylenetetrahydrofolate are discussed, and several possible countermeasures are suggested that might eliminate tritium from the pathways of one-carbon metabolism. (26 references) (auth)

21061 EFFECT OF INHIBITORS OF DNA SYNTHESIS ON UV-SENSITIVE DERIVATIVES OF ESCHERICHIA COLI STRAIN K-12. Green, Michael H. L.; Donch, John; Greenberg, Joseph (Palo Alto Medical Research Foundation, Calif.). Mutat. Res.; 9: 149-54(Feb 1970).

The effect of two chemicals which inhibit DNA synthesis of uv-sensitive strains of Escherichia coli were examined. The wild-type and an Hcr strain were resistant to nalidixic acid (NA) and 5-fluorouracil deoxyriboside (FUDR). Three RecA strains, a RecB and a Lon strain were sensitive to both agents. The sensitivity of an ExrA strain was intermediate. (auth)

21062 AN INCORRECT RELATIONSHIP BETWEEN THE BUILDUP OF ^{90}Sr AND ^{144}Ce IN FRESHWATER PLANTS. Piskunov, L. I. Dokl. Akad. Nauk SSSR; 188: 917-19(1 Oct 1969). (In Russian).

Freshwater plants possess relatively high buildup factors for radionuclides. The statistical correlation of these factors was examined by studying the buildup of ^{90}Sr and ^{144}Ce on the basis of previously published data, on K_{Sr} and K_{Ce}. An inverse dependence was established by means of the statistical treatment of the results obtained by correlative and regressive analyses using the least-squares method. The thus confirmed mutual dependence of the buildup factors of the two elements by two groups of fresh water plants indicates that in the biocenosis the microelements Sr and Ce must be considered as antagonists. (TTT)

21063 RENAL CLEARANCE OF TECHNETIUM (^{99m}Tc) AS PERTECHNETATE. Dayton, David A.; Maher, Frank T.; Elveback Lila R. (Univ. of Minnesota, Rochester). Mayo Clin., Proc.; 44: 549-51(Aug 1969).

The standard clearance of $^{99m}TcO_4^-$ in human patients, together with simultaneous clearances of inulin and of p-aminohippurate (PAH), was reported and discussed. Simultaneous standard clearances of $^{99m}TcO_4^-$, inulin, and PAH were determined in 38 patients. The filtration clearance of $^{99m}TcO_4^-$ at the glomerular membrane

was considered to be equal to that of inulin. Differences in their ultimate clearances at the level of bladder collection were assumed to be related to tubular function. The tubular reabsorption (TR) of $^{99m}TcO_4^-$ was calculated as % of filtered load. The clearance of $^{99m}TcO_4^-$ represented a small and reproducible fraction of the simultaneous clearance of inulin. The mean $^{99m}TcO_4^-$ clearance and standard error of the mean in the 38 patients were 13.5 ± .47% of inulin clearance, with a corresponding mean tubular reabsorption of 86.5 ± .47%. The data did not afford direct evidence for the site of tubular reabsorption of $^{99m}TcO_4^-$ in man. The values for tubular reabsorption of $^{99m}TcO_4^-$ approximated closely those commonly accepted for reabsorption of sodium and of water in the proximal tubule of man. It was considered to be possible that tubular reabsorption of $^{99m}TcO_4^-$ was indeed related to reabsorption of the proximal tubule. (BBB)

21064 UPTAKE AND STORAGE OF THOROTRAST BY THE RODENT YOLK SAC PLACENTA: AN ELECTRON MICROSCOPIC STUDY. Carpenter, S. J.; Ferm, V. H. (Dartmouth Medical School, Hanover, N. H.). Amer. J. Anat.; 125: 429-56(Aug 1969).

Electron microscopy was used to investigate the uptake and storage of electron-dense particulate matter by the rodent yolk sac placenta. Pregnant hamsters were given single intrauterine injections of Thorotrast on day 13, 14, or 15 of gestation and killed at intervals between 15 min and 48 hr thereafter. Electron microscopic examination of yolk sacs removed from the injected animals revealed the rapid and progressive uptake of the tracer particles by the visceral epithelial cells of these fetal membranes. Pinocytic vacuoles (phagosomes) containing Thorotrast were visible in the apical cytoplasm of epithelial cells as early as 15 min after injection and became increasingly abundant in these cells at later post-injection intervals up to 18 hr. Epithelial cells which became fully engorged with Thorotrast vacuoles exhibited various pathologic changes, possibly caused by the interference of the metabolically inert metal particles with intracellular digestive mechanisms of the lysosome system. There was no evidence, however, of transport of Thorotrast particles through or between the yolk sac epithelial cells. The connective tissue spaces and blood vessels of the yolk sac, as well as underlying fetal compartments, were free of the tracer particles at all observed intervals after injection. (BBB)

21065 EXPERIMENTAL PANCREATIC SCANNING: PRELIMINARY RESULTS USING INTRA-ARTERIAL ^{75}Se-SELENOMETHIONINE AND HORMONE STIMULATION. Kupic, Edward A.; Kasenter, Albert G. (Univ. of Vermont, Burlington). Radiology; 93: 1376-9(Dec 1969).

Measurements of the liver and pancreatic uptake of ^{75}Se-selenomethionine in the dog have been obtained. A comparison is made between intravenous and intra-arterial injection, with particular emphasis on differences observed when the pancreas was stimulated with secretin or pancreozymin. The results of these measurements as well as in vitro and in vivo scans indicate that intra-arterial administration of the isotope following pancreatic stimulation may be a valuable refinement in the diagnostic approach to the pancreas and pancreatic disease. (auth)

21066 COMPARATIVE KINETICS OF CALCIUM AND FLUORIDE IN RABBIT BONE. Costeas, Aristides. Ithaca, N. Y.; Cornell Univ. Medical Coll. (1968). 161p.

Thesis.

The experimental studies presented in this thesis were designed to study the short term uptake of ^{18}F and ^{47}Ca in relation to the different physiological factors which control the rate and level of the uptake in bone due to the exchange reactions. The two isotopes were injected intravenously in rabbits at approximately the same time. The activity of the isotopes in blood and the retention in muscle, skin and bone were measured at different intervals after the administration of the isotope. Using these data a phantom approximating the leg of the rabbit was calibrated. The calibration curve was used to determine the uptake of the two isotopes in the tibia from measurements of activity made over the intact leg of the living animal as a function of time. These measurements were made in different animals under normal conditions and were repeated in some animals after administration of parathyroid hormone. Both ^{47}Ca and ^{18}F uptake in cortical bone were shown to be linearly related to part of the water content of the bone which was called active water in contrast to the rest of the water which was called inactive. Parathyroid hormone (PTH) was shown to increase by more than 50% the level of uptake of ^{18}F in cortical bone. This increase led to the conclusion that blood flow does not limit the rate of uptake of isotopes in bone. A computer program was written which by iteration fits the experimental data with a sum of exponentials determining the intercepts and the exponential coefficients, using a least squares method. The blood activity of both ^{47}Ca and ^{18}F was described by the sum of two exponentials. A model consisting of two compartments was designed to explain the kinetics of the two isotopes. Blood is considered as an infinite size pool the activity of which varies with time as determined experimentally. The exchangeable calcium or fluoride of the diaphysis of the rabbit tibia is considered as another compartment. In this model only the local kinetics are considered. The model requires that the uptake should be described by the sum of three exponentials. The ratio of the two pools was close to the ratio of the abundance of the two elements in bone. The size of the exchangeable pool or fluoride was shown to increase when the rabbits were treated with PTH. These results strongly suggest that the uptake of ^{18}F and ^{47}Ca in bone depends on the amount of fluoride and calcium available for exchange which in turn is related to the metabolic activity of the bone. The amount of exchangeable calcium and fluoride is higher the higher the rate of bone formation and the higher the rate of bone resorption. (Diss. Abstr.)

21067 EFFECT OF OVARIAN HORMONES ON THE INCORPORATION OF ^{32}P INTO TISSUE FRACTIONS BY MAMMARY GLAND AND LIVER OF ADULT VIRGIN RATS. Majumdar, G. C.; Ganguli, N. C. (National Dairy Research Inst., Karnal, India). Indian J. Biochem.; 6: 216-19(Dec 1969).

Stilbestrol administration stimulated the incorporation of ^{32}P into phosphoprotein (1.5-fold), RNA (2.5-fold), and trichloroacetic acid soluble organic phosphates (1.5-fold) by rat mammary gland. The hormone did not exert any notable effect on the absorption of ^{32}P by mammary gland. Progesterone alone or in combination with stilbestrol did not influence the synthesis of RNA or the absorption of ^{32}P by mammary gland. However, progesterone and stilbestrol together enhanced markedly (3-fold) the phosphorylation of proteins by mammary gland. The results suggest a synergistic relation between stilbestrol and progesterone in relation to the phosphorylation of proteins by mammary gland. None of the individual hormones or their combination had any significant effect on the synthesis of RNA, phosphorylation of proteins, and the uptake of ^{32}P-orthophosphate by rat liver. The phosphorylation of blood serum proteins also remained unaffected after hormone treatments. (auth)

21068 RADIOACTIVE INULIN, SULFATE AND CHLORIDE SPACES, AND ELECTROLYTES IN THE THYROID GLAND OF RATS AT DIFFERENT AGES. Chow, S. Y.; Woodbury, D. M. (Univ. of Utah, Salt Lake City). J. Endocrinol.; 45: 197-205 (Oct 1969).

Distribution of ^{131}I, ^{36}Cl, ^{35}S-sulfate, and ^{14}C-inulin was studied in male rats 3 to 17 weeks old. The thyroid/serum (T/S) radioiodine ratio, histological measurements of follicles, and electrolyte content of the thyroid gland were also determined. The thyroid ^{14}C-inulin space of animals of different ages was not significantly different, but thyroid $^{35}SO_4^{2-}$ space varied with age, the youngest rats having the largest value. Histological measurements indicated that in the thyroid follicles the epithelial cells were much thinner and luminal volume was much larger in young than in old animals. In older rats, the $^{35}SO_4^{2-}$ space was equal to the sum of ^{14}C-inulin (stromal) and the histologically determined luminal spaces. In the younger animals, although the $^{35}SO_4^{2-}$ space was larger than in the older animals, it was still not large enough to equal the sum of the volumes determined by the ^{14}C-inulin and the direct histological measurements of the lumen. This is due to the high colloid content in the follicular lumen of the young rats. The lower thyroid ^{131}I-T/S ratio found in younger rats also indicated that the thyroid gland was less active than in older animals. The volume of distribution of thyroid Cl^- calculated from the chemically determined data of the plasma and of the thyroid tissue concentrations of rats of different ages was the same as that determined by $^{36}Cl^-$. (BBB)

21069 COMPARATIVE STUDY OF THYROID UPTAKE CURVES OF RADIOIODINE AND LABELED HORMONAL IODINE DURING THE TRIIODOTHYRONINE INHIBITION TEST (WERNER's TEST): A REPORT ON 100 CASES. Jaffiol, C.; Pastorello, R.; Baldet, L.; Mirouze, J. (Univ., Montpellier, France). Rev. Fr. Endocrinol. Clin. Nutr. Metab.; 10: 31-56(Jan-Feb 1969). (In French).

The metabolism of radioiodine and of organically bound iodine was studied in 90 patients. In the 100 tests that were performed, in 71% of the patients radioiodine fixation in thyroid gland and the plasma level of labeled hormone after 24 hr showed parallel variations. In 29% of these cases, only 1 of these 2 parameters was modified by triiodothyronine administration. Examination of these results along with clinical, therapeutic, and other data led to the conclusion that a diagnosis of hyperthyroidism can be eliminated with certainty only when the uptake curve and labeled plasma percentage are decreased markedly and in a parallel direction. The alteration of only one of these parameters is insufficient and does not allow rejection of this diagnosis. The hyperthyroidism prognosis is more favorable when the percentage of labeled hor-

mone is sensitive to the triiodothyronine test dose. The results confirmed the importance of analyzing the variation between the plasma ^{131}I-labeled hormonal fraction and ^{131}I thyroid fixation during the Werner test, both for the diagnosis and therapeutic management of hyperthyroidism. (BBB)

Radiation Effects

Refer also to abstracts 20790, 21210, and 21270.

21070 (AD-695772) INDUCTION OF FATTY ACID SYNTHESIS IN CULTURED MAMMALIAN CELLS: EFFECTS OF CYCLOHEXIMIDE AND X RAYS. Raff, R. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Sep 1969. 30p. (AFRRI-SR-69-13). CFSTI.

It was found that L cells deprived of exogenous fatty acids responded adaptively by increased synthesis of fatty acids. This adaptive increase was found to be sensitive to cycloheximide presented at the time of removal of exogenous lipids, but was not sensitive to cycloheximide added six hours after removal of lipids. It was concluded that the adaptive increase in fatty acid synthesis represents a case of enzyme induction. The effect of x rays on this process was studied. It was found that induction was inhibited to a greater extent than total protein synthesis. Factors of potential importance to such an effect are discussed. (auth) (TAB)

21071 (COO-1793-2) EFFECTS OF ULTRAVIOLET RADIATION ON ALGAE: MECHANISM OF INACTIVATION AND REPAIR. Annual Progress Report, May 1, 1969-April 30, 1970. Small, Gary D. (South Dakota Univ., Vermillion. School of Medicine). Contract AT(11-1)-1793. 4p. Dep. CFSTI.

Photoreactivating enzyme activity was found in Ochromonas danica (Chrysophyta), Euglena gracilis (Euglenophyta), and Chlamydomonas reinhardi (Chlorophyta). Studies were initiated to determine if enzyme activities of chloroplasts and nuclei were caused by two different proteins. Studies on detection of uv-induced photoproducts in DNA of algae included effects of deoxynucleosides on uptake of radioactive thymine by DNA of Euglena. Experiments were conducted on effects of caffeine and acriflavine on survival of uv-irradiated Euglena and on dark repair mechanisms of Euglena. Studies on enzymes in Chlamydomonas that may be involved in excision-repair mechanisms were begun. (H.L.W.)

21072 (RLO-353-40) THE INFLUENCE OF TEMPERATURE ON RADIATION-INDUCED OXYGEN-DEPENDENT AND -INDEPENDENT DAMAGE IN BARLEY SEEDS. Conger, B. V.; Hileman, J. R.; Nilan, R. A.; Konzak, C. F. (Washington State Univ., Pullman. Dept. of Agronomy). [1970]. Contract AT(45-1)-353. 17p. Dep. CFSTI.

Himalaya barley seeds of 10.0% water content were exposed in a partial vacuum to various doses of ^{60}Co gamma rays at different temperatures ranging from −78 to 50°C. In one set of experiments the seeds were hydrated immediately after irradiation in either oxygenated or oxygen-free water at 0°C. In another series of experiments the seeds were stored for various periods of time at different temperatures before hydration. Changes in free radical signal during post-irradiation storage under comparable conditions were measured by EPR in one experiment. The oxygen enhancement ratio (OER) was found to be greatest in seeds irradiated at lower temperatures. The OER decreased as the temperature during irradiation was increased. There was no observable oxygen-effect (OER = 1) if the seeds were irradiated at 50°C. Although oxygen-dependent damage decreased with increasing irradiation temperature, oxygen-independent damage increased. A decrease in oxygen-dependent damage during storage was observed with increasing storage temperature. The development of a long term oxygen-independent damage component became apparent in irradiated seeds stored at 30 and 50°C. Otherwise, there was no storage response if the seeds were hydrated in oxygen-free water after post-irradiation storage. Radiation-induced free radicals that were not associated with oxygen-dependent damage were also observed. (auth)

21073 EVIDENCE FOR A CYCLIC ^{32}P LABELING OF DEOXYRIBONUCLEIC ACID IN IRRADIATED L CELLS. Sanders, J. L.; Dalrymple, Glenn V.; Baker, Max L.; Wilkinson, K. P.; Moss, A. J. Jr. (Univ. of Arkansas, Little Rock. Veterans Administration Hospital, Little Rock, Arkansas). Radiat. Res.; 41: 602-13 (Mar 1970).

Mouse L cells show a cyclic ^{32}P labeling of DNA following relatively low dose of x rays. This effect appeared for cells that were starved or treated with 2,4-dinitrophenol (DNP) but not for cells irradiated in growth medium. The response consisted of a rapid uptake and loss of label. Changes in ATP metabolism paralleled the cyclic labeling of DNA. This behavior possibly explains the enhanced repair of radiation injury previously described for DNP treated cells. (auth)

21074 THE LONG-TERM EFFECTS OF X-RADIATION ON THE GOITROGENIC RESPONSE OF AND IODIDE TRAPPING BY THE RAT THYROID. Philp, James R.; McIntosh, John A. R. (Univ. of Aberdeen, Scotland). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 386-91(Feb 1970).

The modifying effects of 1,000 Rads x radiation on the goitrogenic response of the rat thyroid to methylthiouracil administration were studied at intervals up to one year after irradiation. Compared to the normal goitrogenic response, 1,000 Rads x radiation caused no cell death but resulted in a marked diminution in the 10 day goitrogenic response observed immediately after irradiation. Over the following 12 months, there was still no evidence of cell death nor was there any further reduction in the overall reproductive capacity of the thyroid follicular cell population compared to that observed immediately after irradiation. It is, therefore, concluded that a radiation partial thyroidectomy which requires the combination of significant cell death along with significant reproductive survival is intrinsically impossible in the rat using homogeneous organ irradiation. As 1,000 Rads x radiation does not produce a significant number of nonfunctioning viable follicular cell mutants, a functional radiation partial thyroidectomy with homogeneous thyroid irradiation is also impossible. Doses of 1,000 Rads x radiation delivered to the thyroid had no effect on the uptake of intraperitoneally injected ^{132}I by the rat thyroid. (C.H.)

21075 5-THYMINYL-5,6-DIHYDROTHYMINE FROM DNA IRRADIATED WITH ULTRAVIOLET LIGHT. Varghese, A. J. (Univ. of Texas, Dallas). Biochem. Biophys. Res. Commun.; 38: 484-90(6 Feb 1970).

The major thymine-derived product (P_3) was isolated and characterized from DNA irradiated with ultraviolet light at low temperature (−78°C). The most probable structure of P_3 was 5-thyminyl-5,6-dihydrothymine. The mechanism proposed for the formation of P_3 in DNA involves the addition of a thyminyl radical to the 5-position of a thymyl radical. (C.H.)

21076 MECHANISMS INDUCING THE DEVELOPMENT OF PROPHAGES AND SYNTHESIS OF COLICIN. Likhoded, V. G.; Padalko, T. B.; Poverennyi, A. M.; Saenko, A. S.; Tolcheev, Yu. D. (Moscow Research Inst. of Vaccinations and Serums. Obninsk Inst. of Medical Radiology, USSR). Vestn. Akad. Med. Nauk SSR; No. 11, 87-93(1969). (In Russian).

An analysis of literature sources and the results of the authors' own investigations demonstrates that induction of prophage development and of the colicin synthesis under treatment of E. coli bacteria with DNA-tropic agents is caused by nonspecific inactivation of protein repressors. A replication of DNA containing pyrimidine dimers is needed for induction of the prophage or the colicinogenic factor following ultraviolet irradiation. With ultraviolet irradiation the inducing action is caused, apparently, by secondary ultraviolet damages representing gaps in the complementary subsidiary DNA thread that emerged during replication of the dimers containing DNA. It is proposed that the induction of the prophages and colicinogenic factors under the action of DNA-tropic agents is caused by damage in the secondary DNA structure and nonspecific linkage of repressors with the damaged regions. Mechanisms accounting for direct and indirect induction of prophage and colicinogenic factors are discussed on the basis of this hypothesis, and reasons for absence of induction in strains with lost recombination capacity are given. (auth)

21077 RADIOSENSITIVITY OF THE ALLOSTERIC CENTAR OF PHOSPHOFRUCTOKINASE. Kuzin, A. M.; Ermekova, V. M. (Inst. of Biophysics, Moscow). Dokl. Akad. Nauk SSSR; 188: 1166-8(11 Oct 1969). (In Russian).

The catalytic and allosteric centers of phosphofructokinase (PFK), the main ferment of glycolysis were investigated in order to clarify the reason for their high radiosensitivity. Irradiation of the PFK prepared from the muscle of rabbits at a dose of only 0.5 kR resulted in the strong activation of the ferment. Experiments with the irradiated ferment containing an inhibitor indicated the great radiosensitivity of the allosteric centers of the ferment; this is due to the activation of the ferment caused by the decreased allosteric inhibition at low doses of 0.5 to 1.0 kR which result in vivo also in a similar activation. It was concluded that the great radiosensitivity of the allosteric centers is due to the ease of conformational changes of the molecules of the albumin-ferment system under the influence of radiation. (TTT)

21078 THE EFFECT OF LIGHT ON THE PARAMAGNETIC CENTERS OF DNA EXPOSED TO γ-RADIATION. Milinchuk, V. K.; Ryabchenko, N. I.; Pshezhetskii, S. Ya. (Inst. of Physical Chemistry, Moscow. Inst. of Medical Radiology, Moscow). Dokl. Akad. Nauk SSSR; 188: 1094-7(11 Oct 1969). (In Russian)

A previously developed light-interaction technique was applied to the study of paramagnetic centers and radiation defects in γ-irradiated DNA. The DNA preparations which had a molecular weight of 6 to 14 × 10^6 and contained 0.8 to 1.5% of albumin, were isolated from the thymus of calves. The epr spectrum of DNA, γ-irradiated at 77°K was found to consist of a singlet. After irradiation with a γ ≥ 700 mμ light source, the number of paramagnetic centers in the DNA decreased by a factor of almost 2. Exposure to light in this spectral region for 100 to 150 minutes did not destroy completely the centers; shorter-wave length radiation with γ ≥ 450 mμ reduced the original number of centers by a factor of 4 to 5. Radicals corresponding to the thermo and photostable singlet were found to be formed not in the primary radiation act but during the process of interaction of the charged paramagnetic centers during heating. (TTT)

21079 HISTONE-DNA RATIO IN LYMPHOID ORGANS AND LIVER AFTER IRRADIATION. Telia, M.; Reuter, A. M.; Gerber, G. B.; Kennes, F. (Centre d'Etude de l'Energie Nucleare, Mol, Belg.). Int. J. Radiat. Biol. 16: 389-92(1969).

Data are presented of histone and DNA content in different rat organs after irradiation, as assayed by various methods of isolation. The DNA content of liver, spleen and thymus was in agreement with data from other authors. After irradiation, DNA content diminished in spleen and thymus after 6 hours, but the decrease was parallel to that of DNA and the loss of cells, so that the DNA-histone ratio was essentially unaltered. DNA content remained constant in the liver after irradiation. (UK)

21080 ELECTRON MICROSCOPIC AND HISTOCHEMICAL OBSERVATIONS ON THE PULMONARY ALVEOLAR SURFACTANT IN NORMAL AND IRRADIATED MICE. Oledzka-Slotwinska, H.; Maisin, J. R. (CEN, Mol, Belgium). Lab. Invest.; 22: 131-6(Feb 1970).

Electron microscopic observations of the acid mucopolysaccharide alveolar lining of the lung were performed on healthy and x irradiated mice by using colloidal thorium as a specific stain. It is postulated that the mucopolysaccharide layer on the alveolar surface of the membranous pneumocyte is caused by adsorption phenomenon. It was observed that the acid mucopolysaccharides can be adsorbed also on the alveolar basement membrane surface denuded by radiation injury. On the contrary, the acid mucopolysaccharide layer on the surface of granular pneumocytes may constitute an integral part of the cell membrane and may represent a membrane coat as described for the outer membrane surface of other cells. Detachment of this membrane coat after irradiation is thought to represent an effect of radiation injury exerted on the cell membrane. (auth)

21081 CHANGE IN THE REACTIVITY OF THE SULFHYDRYL GROUP TISSUES FOLLOWING WHOLE-BODY IRRADIATION. Speranskaya, T. S. (Moscow Inst. of Biology Development). Dokl. Akad. Nauk; 188: 223-6(1969). (In Russian)

Mice were x-irradiated with 800 R whole-body doses, and the reactions of sulfhydryl groups in the spleen were studied during the development of radiation injuries and during restoration of hematopoiesis. Results showed an increase in sulfhydryl reactions in all spleen tissues. This effect disappeared only under conditions of complete restoration of spleen tissues. (R.V.J.)

21082 ENZYMATIC RNA SYNTHESIS ON IRRADIATED DNA. Hagen, U.; Ullrich, M.; Petersen, E. E.; Werner, E.; Kroeger, H. (Kernforschungszentrum, Karlsruhe. Univ., Freiburg i. B.). Biochim. Biophys. Acta; 199: 115-25(Jan 1970).

The enzymatic RNA synthesis primed by γ- and uv-irradiated DNA was studied. After γ irradiation of primer DNA the total amount of synthesized RNA was measured as well as the number and the length of RNA chains. Further, the number of binding sites for RNA polymerase was determined. The results of the experiments led to the conclusion that the radiation-induced loss of priming activity was mainly due to the formation of a specific lesion in the DNA that stopped the process of RNA synthesis along the strand. The nature of this lesion is discussed. High dose of γ irradiation create new binding sites for the enzyme which may be ineffective in RNA synthesis. Some experiments concerning the mechanism of action of uv light were performed. The formation of new binding sites, ineffective for RNA synthesis as well as the formation of specific lesions, stopping the process of transcription may be responsible for the reduced priming activity of uv-irradiated DNA. (auth)

21083 EFFECT OF RADIUM TREATMENT ON THE ENZYME CONTENT OF VAGINAL FLUID IN CERVICAL CANCER. Goldberg, D. M.; Watts, C.; Hart, D. M. (Western Infirmary, Glasgow). Amer. J. Obstet. Gynecol.; 105: 1192-6(15 Dec 1969).

Vaginal fluid obtained from patients with cancer of the cervix uteri before and after radium treatment was fractionated into extracellular plasma, cell homogenate, and cell supernatant. The activities of ribonuclease (RNAase), 6-phosphogluconate dehydrogenase (PGDH), and β-glucuronidase were measured in certain of these fractions relative to their protein concentration. Radiation decreased the levels of RNAase, especially in the homogenate, and increased PGDH activity, significantly so in the supernatant. A fall in β-glucuronidase in the homogenate almost attained statistical significance. These findings are believed to result from an increased rate of exfoliation of tumor cells, together with a specific effect of radiation upon each enzyme at the cellular level. Study of these changes may be of value in reaching an early assessment of radiotherapeutic response. Alterations in estrogen status, and contamination of the samples by blood, may account for atypical results. (auth)

21084 COMPLEX REPLICATIVE FORM MOLECULES OF BACTERIOPHAGES φX174 AND S13 su105. Gordon, C. N.; Rush, Mark G.; Werner, Robert C. (New York Univ., N. Y.). J. Mol. Biol., 47: 495-503(14 Feb. 1970).

The frequency of occurrence of circular dimers, catenated dimers, and higher oligomers was determined in preparations of the covalently closed, circular DNA of the replicative form of the bacteriophage φX174 following treatment with either DNAase or x radiation. Fifty minutes after infection in the presence of chloramphenicol, 2.3, 1 and 0.3%, respectively, of the three types of molecules were present. The conditions for preparing the specimens for electron microscopy and the criteria for distinguishing circular and catenated dimers on micrographs were formulated so that they can be uniformly applied in a survey of a large number of molecules. A similar survey of a gene IV mutant of bacteriophage S13, blocked in the replication of replicative form, was made. Circular dimers were present, although at a lower frequency than in wild type, indicating that their formation does not necessarily require replication. Catenanes were only slightly reduced in frequency. (C.H.)

Immunology

Refer also to abstracts 21207 and 21296.

21085 PROLONGATION OF HETEROTOPIC CARDIAC ALLOGRAFTS IN DOGS BY TOPICAL RADIATION. Gergely, Nicholas F.; Coles, John C. (Univ. of Western Ontario, London). Transplantation; 9: 193-202(Mar 1970).

The effect of topical x irradiation on the survival of heterotopically transplanted cardiac allografts was investigated in dogs. Seventy-three transplants were done in this series, with 10 animals serving as controls, and the remaining 63 receiving 2400-Rad radiation to the graft in six equal doses, over a period of three weeks. Seventy-five per cent of the radiated grafts maintained viability for periods up to 10 weeks, while 90% of the nonradiated transplants were rejected by the 12th postoperative day. In addition, 12 intact canine hearts irradiated with identical dose and fractionation provided histological controls for the irradiated transplanted group. Electrocardiographic changes and alteration in lactic dehydrogenase values proved to be the most sensitive parameters of early rejection. (auth)

21086 REGIONAL LYMPH NODE IRRADIATION: EFFECT ON IMMUNE RESPONSES. Eltringham, James R.; Weissman, Irving (Stanford Univ., Calif.). Radiology; 94: 438-41(Feb 1970).

The immune reactions in lymphoma patients is incompletely understood. To test the immunosuppressive effect of localized lymphoid irradiation, an inbred rat experimental model was utilized. Regional lymph node x irradiation markedly suppressed the induction of delayed hypersensitivity and humoral antibody formation following sheep erythrocyte antigenic stimulation. (auth)

21087 ALLOGENEIC THYMUS GRAFTS AND THE RESTORATION OF IMMUNE FUNCTION IN IRRADIATED THYMECTOMIZED MICE. Aisenberg, Alan C. (Massachusetts General Hospital, Boston). J. Exp. Med.; 131: 275-86(1 Feb 1970).

Lethally x-irradiated and thymectomized CBA mice are markedly depressed in several immunological parameters (skin homograft rejection, graft-vs.-host activity, and hemolytic plaque-forming cells of the spleen, hemolysin and hemagglutinin formation, and peripheral lymphocyte counts). The ability of homografts of neonatal thymus placed beneath the kidney capsule to restore immunological capacity of such animals was studied. Thymus homografts which share the same H-2 locus with the CBA mouse were permanently tolerated and immunological restoration was complete. Skin from the thymus donor was specifically retained, but third party skin with even minor (non-H-2) incompatibility was normally rejected and hemolytic plaque-forming cells of the spleen were restored. Thymus homografts which differ at the H-2 locus were

promptly rejected and led to accelerated rejection of skin subsequently grafted from the thymus donor. With such H-2 incompatible thymus grafts, third party skin with minor histoincompatibility was retained, while there was slight to moderate restoration of rejection of skin with major (H-2) incompatibility. Graft-vs.-host activity was restored, but there was no return of plaque-forming spleen cells, hemolysins, hemagglutinins, or peripheral lymphocyte counts. In view of the cross-reactivity at the H-2 locus in CBA mice between thymus and third party skin donors, it was felt that restoration of skin rejection and graft-vs.-host activity could be adequately explained on the basis of immunization by the thymus graft and did not require the postulation of true immune restoration or a thymus hormone. (auth)

21088 IMMUNE RESPONSE AND PYRROLE LEVELS IN RAT SERA AFTER A SINGLE INJECTION OF METHIONINE SULPHOXIMINE AS COMPARED WITH THE EFFECT OF WHOLE-BODY IRRADIATION WITH X RAYS. Kolousek, J.; Cabadaj, S. (Charles Univ., Prague. Safarik Univ., Kosice, Czech.). Neoplasma; 16: 625-31(1969).

L-methioninesulfoximine when administered to rats in a dose of 200 mg per kg intraperitoneally changed the albumin-globulins ratio from 0.57 in controls to 0.49 in experimental sera. There was significant increase in pyrrole levels in rat sera after intervals of 6 and 12 hours following a single I. P. administration of L-methioninesulfoximine in a dose of 100 mg per kg of body weight, as compared with controls. Six hours after whole-body x irradiation of rats in doses of 50 R, 100 R, 600 R, and 1000 R there was only a significant increase in the pyrrole levels of rats irradiated with 600 R. When the pyrrole levels were studied 1, 2, 6, 12, 24, and 48 hours after irradiation of rats in a dose of 600 R there was a significant increase 2 hours after irradiation and decrease after 12- and 48-hr intervals. A survival study of rats after the administration of L-methioninesulfoximine in a dose of 200 mg per kg of body weight (LD_{50}), group I, as compared with the effect of x rays in a dose of 550 R (LD_{50}), group II, showed a faster effect than whole-body irradiation. The rats in group I died within 1.3 day, but in the group II within 11.3 days. After administration of L-methioninesulfoximine (200 mg/kg) the rat sera showed a significant decrease in the number of minimum hemolytic complement doses (NMHD) fixed by Paramecium caudatum culture. This effect was also observed after whole-body irradiation with x rays (550 R). It is suggested that the morphological changes produced by methioninesulfoximine in the neurosecretory centers of the hypothalamus are responsible for these changes. (auth)

21089 USE OF HUMORAL OR CELL-BOUND ANTIBODY TO ACHIEVE DEPRESSION OF IMMUNOLOGICAL REACTIVITY. Wigzell, H. (Karolinska Institutet, Stockholm). Antibiot. Chemother.; 15: 82-97(1969).

Three principal approaches to achieve immunological depression by antibody of immunocompetent cells in vivo or in vitro are discussed. Experiments describing antibody production in x-irradiated animals injected with primed cells are also reported. The 3 ways to achieve immunological depression considered are: antibodies against immunoglobulin will under suitable circumstances inhibit the subsequent production of that immunoglobulin class; passively administered antibody against a given antigen will inhibit the production of antibodies against the antigen in a strictly competitive manner; and immunologically competent cells can be eliminated in a specific manner by passing cells through antigen-coated columns. The impact of antigen concentration on the capacity of columns to eliminate immunological memory in passing cells was studied using human serum albumin (HSA). Anti-HSA memory was measured as the capacity of the passing cells to produce antibodies after transfer to sublethally x-irradiated animals together with antigen. Specific elimination of immunological memory cells in passing through antigen-coated columns was also determined. Memory was expressed as capacity to produce antibodies after transfer of equal cell numbers into sublethally x-irradiated animals followed by antigen. (BBB)

21090 CELLS INVOLVED IN CELL-MEDIATED AND TRANSPLANTATION IMMUNITY IN THE RABBIT. I. THE NONINVOLVEMENT OF THE BONE MARROW ANTIGEN REACTIVE CELL IN THE TRANSPLANT REJECTION REACTION. Richter, Maxwell; Abdou, Nabih I.; Midgley, Robert D. (Royal Victoria Hospital, Montreal). Proc. Nat. Acad. Sci. U. S.; 65: 70-3(Jan 1970).

Rabbits were subjected to 800 R total body irradiation to render them immunoincompetent with respect to the humoral immune response. These rabbits were, however, only slightly less capable of rejecting skin allografts than nonirradiated rabbits. Furthermore, the administration of normal or specifically primed bone marrow cells (bone marrow obtained from a rabbit injected one to two days previously with the spleen cells obtained from the prospective skin donor) did not enhance or inhibit the graft rejection reaction. It is concluded that the cells mediating the humoral immune response are different from those mediating the cellular immune response. (auth)

21091 STUDIES ON THE POTENTIATION OF THE CALCIUM-MOBILIZING ACTIVITY OF PARATHYROID HORMONE BY CYSTEINE HYDROCHLORIDE AND GELATIN. Fang, Victor S.; Tashjian, Armen H. Jr. (Harvard Medical School, Boston). Endocrinology; 86: 337-45(Feb 1970).

Cysteine HCl (cys-HCl) enhances the calcium-mobilizing activity of parathyroid hormone (PTH) in rats when the two substances are administered together by sc injection. This effect has previously been attributed to the reducing properties of cysteine. Bovine PTH was administered to rats by sc, ip and iv routes in dilute HCl (at different pH values), and mixed with cys-HCl, other reducing agents and cysteine analogs. Levels of calcium and PTH in serum, determined by radioimmunoassay, were measured at frequent time intervals after treatment. Potentiation by cys-HCl was seen only after sc and ip treatment. Potentiation was accompanied by a smaller early peak of PTH and the persistence of PTH in serum for a longer period than seen in rats treated with PTH in HCl (pH 3 to 4) alone. These effects of cys-HCl were mimicked by administering PTH in 15% gelatin or in HCl adjusted to the same pH value as the cys-HCl solution (pH 2). Unlike cys-HCl, other reducing agents and cysteine free base did not potentiate the calcium-mobilizing activity of native PTH; however, the activity of oxidized PTH was restored by treatment with several reducing agents, but not by low pH. It was concluded that the potentiating effect of cys-HCl on native PTH is due, at least in part, to the low pH of the solution rather than to its reducing properties, and that low pH results in slow absorption and the sustained presence of PTH in serum. (auth)

21092 IRRADIATION OF SENSITIZED LYMPHOCYTES. Andersen, Vagn; Weeke, Eva; Bendixen, Gunnar (Univ. Hospital, Copenhagen). Lancet; 2: 699-700(27 Sep 1969).

Delayed hypersensitivity is transferable with plasma from x-irradiated, sensitized guinea pigs. The most likely explanation is that a factor responsible for cell-mediated immunity, normally bound to cells, is released into the plasma by irradiation. The question was studied whether the factor responsible for the inhibition of leukocyte migration in vitro is released from human lymphocytes during irradiation in vitro. The cell donors were individuals with strong delayed hypersensitivity to Brucella abortus. Lymphocytes were isolated from peripheral blood washed twice, and resuspended (1×10^7 lymphocytes/ml) in Hanks' medium fortified with glucose. The suspension was irradiated with 1000 rad from a ^{60}Co source, immediately centrifuged, and 100 μl of the cell-free supernatant was added to 1-ml culture chambers. The migration of leucocytes from a person not sensitized to brucella was studied. The results were negative. The migration of leucocytes from non-sensitized donors was not inhibited by the supernatant of irradiated, sensitized lymphocytes, whether brucella antigen was added to the migration chambers or not. These results indicate that a migration-inhibitory factor is not released from lymphocytes during irradiation in vitro. (BBB)

Ecology

Refer also to abstracts 20874, 20875, 20969, 21057, 21058, 21062, 21156, and 21185.

21093 (CEA-CONF-1341) EVALUATION OF LIMITING LEVELS FOR THE DISPOSAL OF LIQUID RADIOACTIVE EFFLUENTS IN CONTINENTAL WATERS. Bittel, R.; Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1966]. 15p. (In French). (CONF-690536-1). Dep. CFSTI (U. S. Sales Only).

From French Meeting of the International Association of Limnology, Grenoble, France.

A concept for establishing the maximum limits for the disposal of low-level radioactive waste into seawater is presented as an alternative for the maximum permissible dose. Radiation dose calculations are based on the amount of radioactivity ingested annually by humans consuming seafoods from contaminated waters, using the number of curies of radioactivity in one kg of food, the kg quantity of food consumed, and the seafood/water uptake factor for each radioisotope present in the waste solution. Calculations of the radiation dose to man consuming various quantities of seafood containing various amounts of ^{137}Cs, ^{60}Co, ^{106}Ru, and ^{90}Sr are included. It is suggested that the method may also be used to calculate the radiation dose to man consuming contaminated drinking water or vegetables from soil irrigated with contaminated water. (C.H.)

21094 (CEA-CONF-1464) EXPERIMENTAL AND "IN SITU" CONTAMINATIONS OF AQUATIC ENVIRONMENT BY ^{106}Ru. Ancellin, J.; Bovard, P. (Commissariat a l'Energie Atomique, La Hague (France)). 1969. 8p. (In French). (CONF-691031-1). Dep. CFSTI (U. S. Sales Only).

From 4th International Colloquium on Medical Oceanography, Naples, Italy.

Experimental contaminations of algae and marine invertebrates with soluble or insoluble ^{106}Ru showed that the former leads to concentration factors lower than the latter (by a factor of five up to 10). The high values obtained for the concentration factors in the natural environment where the radioactive wastes are disposed can often be compared to those obtained experimentally. (France)

21095 (CEA-CONF-1465) EVALUATION OF RADIOACTIVE POLLUTION TRANSFER TO OCEAN AND SEA FOOD CHAINS. Bittel, R.; Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1969]. 26p. (In French). (CONF-691031-2). Dep. CFSTI (U. S. Sales Only).

From 4th International Colloquium on Medical Oceanography, Naples, Italy.

In agreement with the latest ICRP recommendations, a proposal is made to use the concept of water contamination levels in place of MPC and to apply it to ocean and sea food chains. The concepts of critical diet, critical radionuclide and evolution towards critical conditions were envisaged. The variation of the parameters used in the calculation of the dose D_1 delivered by the ingestion of ocean and sea food was analyzed. D_1 varies as a function of the ingested quantities Q and of the doses d per unit-weight. These doses vary as a function of both the contamination levels x of the effluents dispersion environment and of the contamination transfer factors to the man. The latter comprise either ecological factors F or physiological factors f of transfer after ingestion. Finally the effect of this variation on the "ingested dose" was tested. Some typical examples were treated. Such researches are proposed as a model for future pollution studies of the aquatic environment. (France)

21096 (COO-1156-35) RADIOECOLOGY OF SOME NATURAL ORGANISMS AND SYSTEMS IN COLORADO. Eighth Technical Progress Report, January 1, 1969–December 31, 1969. Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 1 Feb 1970. Contract AT(11-1)-1156. 40p. Dep. CFSTI.

Investigations were conducted on behavior of radionuclides and radiosensitivity of selected organisms and natural systems in Colorado. Studies on radioiodine retention in mule deer showed that the ^{131}I concentration in the deer thyroid may exceed 850 times the nuclide concentration in deer forage. For studies on effects of age, season, and sex on calcium and strontium kinetics in the mule deer, ^{45}Ca, ^{85}Sr, and ^{90}Sr were administered orally at various times of the year; subsequently analyses were made of antlers, feces, urine, and whole body counts. Muscle tissues were assayed for ^{137}Cs; thyroids were scanned for ^{131}I, and metacarpals were analyzed for ^{90}Sr. Studies or radiocesium kinetics in a montane lake ecosystem included development of a compartment model to determine various lake components, and development of models for determining ^{137}Cs ingestion and ^{134}Cs excretion and tissue distribution in rainbow trout. Laboratory experiments with Gammarus lacustris in aquaria contaminated with ^{134}Cs showed that the concentration factor of these organisms was dependent on the water radiocesium concentration. Studies on effects of γ radiation and social stress on pikas indicated that there was a difference in radiation response of pikas in individual cages and pikas free in enclosures simulating their natural habitat. It appeared that social competition was responsible for the difference in radiation response since food and water were not limiting factors. For studies on radiation effects on the grass plant community, a gamma field was mapped and sector and plot boundaries were determined and staked. Results indicated that although some species in the community were relatively sensitive to ionizing radiation, the structure of the community was relatively insensitive. Grassland arthropods provided a practical means of investigating higher trophic levels within a radiation field of limited size. Arthropods were trapped, preserved in formalin, and specimens were counted and identified. The most abundant families were Formicidae (ants), Carabidae (ground beetles), Tenebrionidae (darkling beetles), and Scarabaeidae (lamallicorn beetles). Ants were by far the most abundant insects collected. (H.L.W.)

21097 (COO-1795-2) EFFECTS OF LIMNOLOGICAL FACTORS ON UPTAKE OF ^{137}Cs FALLOUT BY FISH. Technical Progress Report, June 1969–February 1970. Kevern, Niles R.; Spigarelli, Steven; Seelye, James (Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife). Contract AT(11-1)-1795. 13p. Dep. CFSTI.

Bass samples were collected from five lakes during 1968 and from all six lakes during 1969. A new technique of wet ashing fish was developed which decreases the analysis time and ensures against the loss of cesium caused by thermal volatilization. A portion of the bass samples was analyzed for ^{137}Cs and cesium and the results show an inverse relationship with the specific conductance of the water and a direct relationship with the concentration of ^{137}Cs in the water. Analyses of lake water have been the most elusive aspect of the study. A new technique involving the use of an ion-exchange resin that is specific for cesium was developed. Preliminary data collected during the fall of 1969 and laboratory testing indicate that reliable analyses of ^{137}Cs and cesium in lake water will be possible. Although the interpretation of the data cannot be conclusive at this time, the premises upon which the study is based have been supported. (auth)

21098 (EUR-4218) STUDY OF THE DIET OF THE POPULATIONS OF ELEVEN REGIONS IN THE EUROPEAN COMMUNITY AIMED AT DETERMINING THE LEVELS OF RADIOACTIVE CONTAMINATION. Cresta, M.; Ledermann, S.; Garnier, A.; Lombardo, E.; Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 590p. (In French). Dep. CFSTI (U. S. Sales Only).

The present work deals with inquiries made during the period 1963 to 1965 into the diet of 9,000 families in eleven regions of the European Community, and with the process of interpreting them in order to estimate the levels of radioactive contamination in the food chain and the environment. It includes four parts. Part one describes the method and organization of the dietetic inquiries. Part two tabulates the results concerning mean individual intake, monthly and annual, in each of the eleven regions, obtained by a partial processing of the data relating to a limited sample of 3,725 families, and based on the calculation of the unit of consumption. The results concern the different foodstuffs, dietetic principles, minerals, oligoelements and vitamins. By processing all the information obtained it was possible to determine the intakes of thirteen groups of foodstuffs in each of the eleven regions for individuals classified in nine age groups. The statistical method employed and the results obtained are set out in part three. A polynomial mathematical model has been constructed that expresses these results as a function of age. It is described in part four, followed by a presentation of the results in the form of curves and tables showing the relative contributions of thirteen groups of foodstuffs to the intake of certain elements that are of interest from the radiological protection angle. (auth)

21099 (FRL-5) RADIOACTIVITY IN SURFACE AND COASTAL WATERS OF THE BRITISH ISLES, 1968. Mitchell, N. T. (Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Radiobiological Lab.). Nov 1969. 39p. Dep. CFSTI (U. S. Sales Only).

Radioactive contamination of the marine environment of coastal areas of the British Isles during 1968 was monitored, with emphasis on areas where radioactive wastes were discharged into the sea. Samples were collected from representative locations. Data are included on the total α and β activities, and content of ^{106}Ru, ^{95}Zr, ^{95}Nb, and ^{144}Ce in samples of Porphyra; the content of ^{106}Ru in laverbread, in which Porphyra is used as a raw ingredient; the γ activity and content of ^{144}Ce, ^{106}Ru, ^{95}Zr, and ^{95}Nb in samples of silt; the content of ^{134}Cs, ^{137}Cs, and ^{40}K in the flesh of plaice, a representative fish; the total β activity and content of ^{144}Ce, ^{137}Cs, ^{106}Ru, ^{95}Zr, and ^{95}Nb in samples of Fucus spiralis and Fucus vesiculosus; and the content of ^{137}Cs, ^{40}K, ^{106}Ru, ^{95}Zr, and ^{95}Nb in samples of seawater. The γ dose rate over silt banks in various locations was also measured. The total β activity and content of ^{134}Cs, ^{137}Cs, ^{60}Co, ^{55}Fe, ^{110}Ag, ^{32}P, ^{106}Ru, ^{65}Zn, ^{95}Zr, and ^{95}Nb were measured in samples of seafood from the coastal waters. The flesh of lake fish and lake plants were examined for content of these radioisotopes to establish background data. Results showed that radiation exposure of the public was within internationally acceptable levels at all sites monitored and that the control of waste discharge had been achieved with complete safety. (C.H.)

21100 (HASL-217(App.)) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, SEPTEMBER 1, 1969–DECEMBER 1, 1969. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Jan 1970. 395p. Dep. CFSTI.

This supplement to the Health and Safety Laboratory Fallout Program quarterly report contains data on: ^{89}Sr and ^{90}Sr in monthly deposition at world land sites; ^{90}Sr deposition at Atlantic Ocean weather stations; ^{238}Pu, ^{239}Pu, and ^{240}Pu deposition at selected sites in Australia and North and South America; radionuclide content of surface air at selected sites; ^{90}Sr/Ca ratio in liquid and powdered milk in New York; and ^{137}Cs/^{90}Sr ratio in New York City tap water. All data are presented in tabular form.

Tables listing the abbreviations and conversion factors used in the supplement and the half-lives of important radionuclides are also included. (E.R.B.)

21101 (RISO-201) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1968. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1969. 81p. Dep. CFSTI (U. S. Sales Only).

Measurements of fall-out radioactivity in Denmark in 1968 are reported. Strontium-90 was determined in samples from all over the country of precipitation, soil, ground water, sea water, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables, fruit, total diet, drinking water, and human bone. Furthermore Sr-90 was determined in local samples of air, rain water, grass, sea plants, fish, meat, and human milk. Cs-137 was determined in milk, grain products, potatoes, vegetables, fruit, total diet, meat, and human milk samples, and Cs-137 was measured by whole-body counting in persons from a control group at Risoe. Estimates of the mean contents of radiostrontium and radiocesium in the human diet in Denmark in 1968 are given. The γ-background was measured regularly at locations around Risoe, at ten of the State experimental farms and in an area in Sealand, one in Jutland where future nuclear power plants might be located, and along the shores of the Great Belt. Finally the report includes, as previously, regular surveys of environmental samples from the Risoe area. (Denmark)

21102 (SZS-14/69) DETERMINATION OF THE MEAN POPULATION BURDEN FROM NATURAL EXTERNAL RADIATION IN THE G.D.R. Ohlsen, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Nov 1969. 69p. (In German). Dep. CFSTI (U. S. Sales Only).

Measurements of the local dose rate from natural external radiation (without neutrons) were made in the G.D.R. during 1965 and 1966 to estimate the mean population burden. An air-equivalent 23-l-ionization chamber and scintillation detectors were used for the measurements. 1097 measurements were made out of doors, and 667 inside of houses. Results were attributed to characteristics of the environment like geological formations, towns, roads, and to the types of houses. By various methods of averaging, considering cosmic radiation out of doors, frequency of the measured results, population densities, and mean times of residence, the following values were obtained: mean population burden inside of houses 106 mr/yr, out of doors (only terrestrial component) 89 mr/yr for country people, mean population burden from cosmic radiation 32 mr/yr. An estimation of the mean doses to the gonads for the whole population proves 51 mrem/yr from terrestrial radiation, 32 mrem/yr from cosmic radiation (without neutrons), altogether 91 mrem/yr from all components of natural external radiation. (auth)

21103 THE PRINCIPLE OF HOMEOSTASIS AND THE CHANGES IN THE BLOOD PICTURE OF CHILDREN DUE TO CHANGING CONDITIONS IN THE ENVIRONMENT. Hecko, I.; Grunt, J.; Ambrus, J. (Research Inst. of Hygiene, Bratislava). J. Hyg., Epidemiol., Microbiol., Immunol.; 12: 488-97(1968).

Repeated hematological examinations of 60 children about 7 yr old, who resided in the immediate vicinity of a nuclear power plant, showed no statistically significant differences between groups of town and country children despite different environmental and hygienic conditions of life. However, after the beginning of the 1963 school yr, statistically significant differences were found between some hematological values determined at the start and before the end of the same school yr. Initially, the values of hemoglobin and hematocrit were significantly lower, and the leukocyte counts were significantly higher than those of the second examination. The average values of the first hematological examination were regarded as the manifestation of a temporary divergence from the equilibrium state. The closest correlation was found between the length of time spent outdoors by country children and the hemoglobin values, but the correlation did not prove to be statistically significant. Some changes in average hematological values were regarded as relatively sensitive indicators of influences of infections. They did not signalize every change in the constituent components of environment that influenced man. Results of repeated hematological examinations in groups of 14-yr-old school children were compared with the corresponding values of the 7-yr-old children. (BBB)

21104 EXCRETION AND RETENTION BY HUMANS OF CHRONICALLY INHALED URANIUM DIOXIDE. Quastel, M. R.; Taniguchi, H.; Overton, T. R.; Abbatt, John D. (Dept. of National Health and Welfare, Ottawa). Health Phys.; 18: 233-44(Mar 1970).

In the investigation described, 15 long term workers (1-20 yr), chronically exposed to insoluble uranium compounds, were studied by whole-body counting of ^{238}U together with urine and fecal analysis. The ratio of thorax burden to daily urine excretion was 560 to 1690, but considerably larger values were observed for two of the longest exposed subjects. The data suggest an approximate daily urine excretion of 20 to 50 μg/day, corresponding to burdens of 30 mg (0.01 μCi), the ICRP maximum permissible lung burden for insoluble uranium. Fecal concentrations of uranium decreased exponentially with half-time of 6 to 30 hr, and indicate that recent exposure to insoluble uranium is more readily detected by analysis of the feces than of urine. Urinary uranium was excreted in direct proportion to that of creatinine. The average ratio of excretion rate of uranium in the urine to its plasma concentration was increased in subjects with greater body burdens. (auth) (UK)

21105 TRANSFER OF RADIOISOTOPES BETWEEN DETRITUS AND BENTHIC MACROINVERTEBRATES IN LABORATORY MICROECOSYSTEMS. Wilhm, Jerry L. (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 277-84 (Mar 1970).

The transfer of ^{106}Ru, ^{137}Cs, and ^{60}Co between detritus or algae and benthic macroinvertebrates was studied in laboratory microcosms. Detritus or algae containing the radioisotopes was collected from a lake which serves as a settling basin for partially decontaminated waste water, and invertebrates were taken from a constant temperature spring. Four species of detritus feeders, each with a different feeding mechanism, and one carnivorous species were studied. Microecosystems were established in 2-l. Erlenmeyer flasks and two systems each were sacrificed after specified time periods. Mean initial activity in picocuries/ash-free g in whole detritus was 2.88×10^4 for ^{106}Ru, 6630 for ^{137}Cs and 6870 for ^{60}Co, while these values in Spirogyra were 1.35×10^5, 4930, and 6.21×10^4, respectively. The radioisotopes were present in intermediate concentrations in pulverized detritus. When whole detritus was used, activity of all three radioisotopes was greater in Limnodrilus hoffmeisteri than in Stictochironomus annuliorus. When pulverized detritus or algae was used as a source of nourishment, the reverse was true. Physa heterostropha was intermediate between Limnodrilus and Stictochironomus in activity. Peak concentrations of the radioisotopes in detritus feeders were reached by day three, while the carnivore Procladius had a delayed uptake and increased in activity until day 14. ^{106}Ru was detected in all life stages and exuviae of Stictochironomus, but ^{137}Cs and ^{60}Co were detected only in larvae. Activity of ^{106}Ru in adults was less than in larvae. (auth) (UK)

21106 HEALTH PHYSICS ASPECTS OF TRITIUM LUMINOUS DIAL PAINTING. Moghissi, A. A.; Toerber, E. D.; Regnier, J. E.; Carter, M. W.; Posey, C. D. (Southeastern Radiological Health Lab., Montgomery, Ala.). Health Phys.; 18: 255-61(Mar 1970).

A survey of a luminous dial painting plant is described. Under the conditions investigated skin contamination was indicated as a major mode of entry of tritium into the body of the workers. A new unit, gram-Lambert (g-L), is proposed for comparison of radioactive luminous paints. A maximum tritium activity which may be processed by a worker without exceeding the maximum permissible body burden is proposed. (auth) (UK)

Genetics and Cytogenetics

Refer also to abstracts 21202, 21203, 21271, 21319–21321, 21323, and 21325.

21107 (STI/PUB-173) EFFECTS OF RADIATION ON MEIOTIC SYSTEMS. Panel Proceedings Series. Report of a Study Group, Vienna, 8–11 May 1967. (International Atomic Energy Agency, Vienna (Austria)). Mar 1968. 231p. (CONF-670525). IAEA $4.50.

Separate abstracts were prepared for eleven papers presented at the conference. An additional seven papers were presented on various aspects of meiosis. (H.L.W.)

For abstracts of individual papers see: 21127–21135, 21297, and 21322.

21108 (STI/PUB-182) MUTATIONS IN PLANT BREEDING. II. Panel Proceedings Series. Proceedings of a Research Coordination Meeting on the Use of Induced Mutations in Plant Breeding Held in Vienna, 11–15 September 1967. (International Atomic Energy Agency, Vienna (Austria)). Jun 1968. 323p. (CONF-670942). IAEA $6.50.

Twenty-eight papers were presented. Separate abstracts were prepared for 15. The effects of radiation and chemical mutagens on various plants and the importance in plant breeding were discussed. (F.M.M.)

For abstracts of individual papers see: 21136–21147 and 21323–21325.

21109 GENETICS LECTURES. VOLUME I. Bogart, Ralph (ed.). Corvallis, Oreg.; Oregon State University Press (1969). 194p.

Separate abstracts were prepared for four lectures on lateral and linear redundancy of chromosomes; induced genetic variability of kernel yield in barley and wheat following studies with and without selection; nature, induction, and utilization of mutations in higher plants; and transfer of genes from wild relatives to wheat. Additional lectures are included on the protein electrophoresis approach to species relationships in wheat; cytogenetic explorations in the tomato genome; some possibilities of the clone in forest genetics research; number of genes affecting growth in mice; direct and correlated responses to selection in mice; and the evolutionary role of dominant genes. (H.L.W.)

For abstracts of individual papers see: 21110–21113.

21110 LATERAL AND LINEAR REDUNDANCY OF CHROMOSOMES. Swanson, Carl P. (Johns Hopkins Univ., Baltimore). pp 7-18 of Genetics Lectures. Vol. I. /Bogart, Ralph (ed.). Corvallis, Oreg.; Oregon State University Press (1969).

The DNA content of organisms with relation to the total gene content and the phylogenetic increase of DNA per cell are discussed. Studies on lateral redundancy using ultraviolet photography revealed four distinct lateral strands in the anaphase chromosomes of ferns and other plants. When chromosomes of Vicia faba were subjected to trypsinization it was seen that each chromatid consisted of two half-chromatids. Irradiation of premetaphase chromosomes of Tradescantia resulted in half-chromatid aberrations, suggesting that the metaphase chromosome is quadripartite. Autoradiographic studies on chromosomes labeled with radioactive thymidine indicated that the chromosome consists of one double helix in some instances; in others, the chromosome appeared to consist of two double helices. Studies on kinetics of breakage in loops of lampbrush chromosomes were in agreement with the unitary concept, while kinetics of breakage of the interloop areas indicated a double structure. Linear redundancy is discussed with regard to annealing experiments on DNA of Escherichia coli lambda bacteriophage chromosomes, formation of hybrid DNA/RNA by reannealing, and formation of tRNA by cistrons in Drosophila. (H.L.W.)

21111 INDUCED GENETIC VARIABILITY OF KERNEL YIELD IN BARLEY AND WHEAT FOLLOWING STUDIES WITHOUT AND WITH SELECTION. Gaul, Horst (Max-Planck-Institut fuer Zuechtungsforschung, Cologne). pp 69-88 of Genetics Lectures. Vol. I. /Bogart, Ralph (ed.). Corvallis, Oreg.; Oregon State University Press (1969).

Examples of long-term experiments with four barleys and one type of wheat are presented. All experiments, which are not yet concluded, have a similar outline. They start with the random selection of a great number of M_2 plants and an equal number of control plants derived from the same original seed sample. Individual plant progenies are grown in M_3 and following generations, and the variability of the character kernel yield is studied. A correlation between mutagen-induced physiological damage, chlorophyll-mutation frequency, and genetic yield variance was found. An increasing x-ray dose results in decreasing M_1-seedling height and M_1 survival, increasing frequency of M_2-chlorophyll mutations on the one hand, and increasing yield reduction, and genotypic yield variance of M_3 families on the other hand. Even extremely high x-ray doses such as 40,000 R, which lead to 97% killing of M_1 seedlings, produce a large quantity of additional genetic variance. EMS-treatment results in less physiological M_1 damage, more chlorophyll-mutations, and more genetic yield variance as compared to x-irradiation. The action of EMS may be roughly considered as that of a superdose of ionizing radiation. However, it looks as though EMS produces relatively more positive micro-mutations affecting yield. Results from experiments where the whole material was transferred from M_3 to M_4 and M_5 generations without selection show the tendency of a self-improvement of the families derived from mutagenic treatment: the mean yield of these families increases from generation to generation. This can be explained by the effect of natural selection within the families, which evidently takes a direction that is desired by the breeder. In spite of the fact that small plots were used, surprisingly high correlations of the yield means were found between the generations. The correlation coefficients obtained in the various experiments are based on a total of almost 6,000 families. The highest coefficient was 0.45. Results of selection experiments are in agreement with the relatively high yield correlations. A clear response to positive and negative selection was found. Three selection steps in subsequent generations following the M_4, raised the yield mean of the families derived from x irradiation above that of the control which was subjected to the same selection procedure. Results of drill tests conducted over four to eight years show that it is relatively easy to select micro-mutants which have a yielding potential 5% higher than that of their mother line. (auth)

21112 NATURE, INDUCTION, AND UTILIZATION OF MUTATIONS IN HIGHER PLANTS. Nilan, R. A. (Washington State Univ., Pullman). Contract AT(45-1)-353. pp 89-106 of Genetics Lectures. Vol. I. /Bogart, Ralph (ed.). Corvallis, Oreg.; Oregon State University Press (1969). (RLO-353-15).

A review is presented of the nature of induced mutations in plants. Reasons for incomplete knowledge of induced mutations are discussed with emphasis on lack of knowledge of the structure of chromosomes and arrangement of DNA within the chromosome. Induced mutations in plants can be attributed chiefly to deficiencies, duplications, rearrangements, and recombination products of genic elements after normal and unequal crossing over. Mutations at specific loci are discussed with reference to studies on effects of EMS and x radiation on maize and effects of x radiation and thermal neutrons on reversions in barley. Experiments with genes whose phenotypes are expressed in the gametophytic stage give the best evidence that mutations within a locus can be induced in higher plants. Analysis of the effects of various treatment conditions and biological factors has contributed to understanding of mutagenic action. Efficiency of chemical mutagens and radiation for inducing chromosome breakage are discussed. In a review of mutagen specificity an experiment is described on effects of alkylating agents in comparison with γ and x radiation in producing chlorophyll-deficient mutations in barley. Induced mutations in plants are used for genetic analyses, evolution studies, biochemical and developmental analyses, and plant improvement. (H.L.W.)

21113 TRANSFER OF GENES FROM WILD RELATIVES TO WHEAT. Sears, E. R. (Univ. of Missouri, Columbia). pp 107-20 of Genetics Lectures. Vol. I. /Bogart, Ralph (ed.). Corvallis, Oreg.; Oregon State University Press (1969).

Transfer of genes to wheat from Aegilops, Agropyron, Secale, and Haynaldia was restricted by failure of the chromosomes of these relatives to pair with those of wheat. Pairing and crossing over can be induced, however, by removing or inhibiting the effect of chromosome 5B, which suppresses pairing of chromosomes that are only "homoeologous" (homologous in part; related). Alien-substitution lines, in which a pair of foreign chromosomes replaces a homoeologous pair of wheat chromosomes, can be used advantageously. In hybrids of such lines with normal wheat, the foreign chromosomes and a homoeologous wheat chromosome are both monosomic and hence available for maximum pairing with each other. Transfer of foreign genes can also be accomplished by irradiation, preferably of alien-addition monosomics or disomics. A foreign segment carrying the desired gene is translocated to a wheat chromosome, and the remainder of the foreign chromosome is allowed to become lost. (auth)

21114 INDUCTION BY N-METHYL-N'-NITRO-N-NITROSOGUANIDINE AND UV LIGHT OF PETITE MUTANTS IN AEROBICALLY AND ANAEROBICALLY CULTIVATED SACCHAROMYCES CEREVISIAE. Mayer, V. W.; Legator, M. S. (Dept. of Health, Education, and Welfare, Washington, D. C.). Mutat. Res.; 9: 193-8(Feb 1970).

Petite mutant induction by N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) and uv irradiation was studied in aerobically and anaerobically cultivated Saccharomyces cerevisiae cells. At any particular level of MNNG or uv, a greater proportion of mutants was obtained from anaerobic than aerobic cells in the surviving population. The proportion of sectored colonies in the surviving population, observed by the tetrazolium dye reduction technique, decreased as mutagen dosage was increased for anaerobic cells but showed only a slight decrease for similarly treated aerobic cells. Mating of petite isolates from MNNG treatment with a known cytoplasmic petite of the opposite mating type revealed that approximately half of the isolates were mutant in a nuclear gene but similar studies with uv-treated cells showed that only a few were mutant in a nuclear gene. (auth)

21115 RADIATION-INDUCED CHROMOSOME DAMAGE IN HUMAN PERIPHERAL BLOOD LYMPHOCYTES IN VITRO. II. RBE AND DOSE-RATE STUDIES WITH ^{60}Co γ- AND X-RAYS. Scott, D.; Sharpe, Heather B. A.; Batchelor, A. L.; Evans, H. J.; Papworth, D. G. (Medical Research Council, Harwell, Eng. Royal Marsden Hospital, Surrey, Eng.). Mutat. Res.; 9: 225-7(Feb 1970).

Human peripheral blood lymphocytes were exposed, in vitro, to acute doses (2-min or 10-min exposures) of 250 kV x rays and ^{60}Co γ rays, or to chronic doses (24-, 48- or 72-hr exposures) of γ rays. Chromosome aberrations were scored at the first mitosis after stimulation with phytohemagglutinin. Yields of dicentric aberrations after x irradiation agreed with those reported by Evans who obtained a dose exponent (n) of 1.17 ± 0.04 on a power

law model. Our dose exponent for acute γ irradiation was 1.24 ± 0.06 and the Relative Biological Effectiveness of ^{60}Co γ rays compared with 250 kV x rays was found to be 0.82 ± 0.03. The acute γ ray data were analyzed on a quadratic model on the assumption that the majority of dicentrics had been induced by a single ionizing track (the linear component) but that some were induced by two independent tracks (the quadratic component). On classical theory only the two-track aberrations should be reduced by reducing the dose-rate (by increasing the exposure time) and the dose–response curve should become progressively more linear. In contrast we found that the dose–response curve for 24-hr γ exposures had a greater curvature (n = 1.52 ± 0.10) than the acute response and the dicentric yields had fallen below the level of the one-track component of the acute curve. It was shown that the reduction in yield for chronic exposures was not the result of a depletion of oxygen during the 24-hr irradiation. It is suggested that the analysis of dose–response curves for exchange aberrations in terms of a dose-rate dependent two-track process and a dose-rate independent one-track process might not be justified. However, further speculation on the present results must await resolution of the discrepancies between different laboratories in the shapes of dose–response curves for radiation-induced chromosome aberrations induced in peripheral blood lymphocytes in vitro. (auth)

21116 GENETIC INSENSITIVITY OF THE MOUSE DICTYATE OOCYTE TO CHRONIC IRRADIATION. Searle, A. G.; Phillips, Rita J. S. (Medical Research Council, Harwell, Berks, Eng.). pp 17-25 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Chronic neutron exposures are known to be much more effective than chronic gamma irradiation for the induction of specific locus mutations in mouse spermatogonia. In order to discover whether the same was true when the long-lasting dictyate stage of the oocyte was irradiated, female mice were exposed for 12 weeks to 0.7 MeV fast neutrons from a reactor or to ^{60}Co gamma rays, or were left unexposed in similar conditions. They were mated one day after the end of treatment to males of a specific locus stock. No specific locus mutations were recovered in the gamma and control series. Only 1 was found in the neutron series, the frequency being about 5% of that in males with a similar dose. When control data were combined with previously published figures of spontaneous mutation frequencies at specific loci in female mice and compared with overall figures for males it was found that the overall frequency in females of 1×10^{-6}/locus/gamete was significantly lower than the frequency in males of 8×10^{-6}. This is in line with previous findings in Drosophila. The very low yields from protracted exposures of females are thought to result mainly from the reported decline in genetic radiosensitivity of dictyate oocytes to practically zero when they are exposed at earlier stages of maturation. The low intensity of the irradiation was almost certainly a contributory factor with the low LET irradiation, possibly also with the neutrons. It is pointed out that the actual magnitude of the intensity effect with low LET irradiation of dictyate oocytes is still uncertain, because there are not yet sufficient data to allow the form of the relationship between oocyte developmental stage and genetic radiosensitivity to be accurately known. Possible reasons for the radiosensitivity and intensity effects are briefly discussed. (auth)

21117 INDUCTION OF TRANSLOCATIONS IN MOUSE SPERMATOGONIA BY X-RAY DOSES DIVIDED INTO MANY SMALL FRACTIONS. Lyon, M. F.; Morris, T.; Glenister, P.; O'Grady, S. E. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 9: 219-23(Feb 1970).

When a total dose of 300 rad x rays was delivered to mouse spermatogonia in a single dose or in successive daily doses of 60 rad, 10 rad, or 5 rad, the incidence of spermatocytes carrying translocations was 6.3, 3.4, 1.3, and 1.7% respectively, i.e., fractionation or protraction of the dose reduced the effect. The possible explanations for this are being studied further. Providing one assumes that premutational damage does not persist for as long as 24 hr, these results indicate that a dose as low as 5 rad is mutagenic to mice. (auth)

21118 WAXY CHARACTER. Eriksson, Goesta (Royal Coll. of Forestry, Stockholm). Hereditas; 63: 180-204(1969).

Genetic and radiobiologic investigations of the waxy character of the endosperm are reviewed. Radioinduced mutations at the waxy locus as well as studies of the gene action within the waxy locus are discussed. In some of the first investigations of the mutagenic effect of irradiation, changes in the waxy character were observed. The nature of the induced mutations were more easily studied following uv irradiation than following x irradiation. In similarity with the x-ray results, uv mostly induced simultaneous changes of linked characters. In investigations of the effect of chronic irradiation in maize, the dose-effect relation was exponential for the induction of several endosperm characters. The exponential relation originated from the fact that these mutants mostly constitute deficiencies which were induced by 2-hit events. In studies of the mode of action of 4 types of radiation (uv, thermal neutrons, x and γ rays), although some differences were reported among the agents concerning the number of breaks appearing in different regions in the short arm of chromosome 9, the similarities were greater than the differences. The radioinduced recessive mutations of the endosperm characters located in the short arm of chromosome 9 were evidently due to losses of chromosomal material. Following acute irradiation of barley spikes containing pollen mother cells (PMC) in the meiotic stages, an exponential increase of the back mutation rate was found in the dose range of 0 to 400 R. When a separate analysis of pollen originating from central and lateral spikelets was performed, the latter showed the highest mutation rates, believed to be due to clustering in lateral spikelets. No increase was seen in the back mutation rate following 7 days fractionated irradiation of maize tassels (dose range 500 to 1680 R). In investigations involving acute irradiation during meiosis of the PMC of maize, it was shown that the lowest doses (1 to 12 rad) produced higher mutation rates per dose unit than the moderate doses (50 to 100 rad). At the highest dose levels (100 to 400 rad) 2-hit events leading to the waxy phenotype probably became predominant, thus causing an exponential increase of the dose effect relation in this dose region. In ^{90}Sr experiments it was possible to estimate the genetic effects of extremely low doses. Thus for mutations to the waxy phenotype it was shown that a daily dose of 0.03 rad produced a mutation rate significantly higher than the spontaneous rate. The lowest doses were shown to produce more mutants per rad unit than the highest doses investigated, thus causing a hump at the low dose level on the dose-effect curve. On the other hand the reversions showed an exponential dose-effect relation, in agreement with observations following acute γ irradiation. (BBB)

21119 BIOSATELLITE II. Schmid, Roswitha. Naturwiss. Rundsch.; 22: 24-5(Jan 1969). (In German).

The problems and nature of biological experiments conducted on Biosatellite II are described and reviewed. One group of experiments was conducted to show whether organisms were affected by irradiation more during space flight conditions than on earth. It was possible to differentiate between effects of irradiation and weightlessness. In experiments where 200 to 4000 R of γ irradiation were given by a ^{85}Sr source to Tradescantia, Neurospora, Drosophila, Tribolium, and Habrobracon, the effects varied with the cell type and state of the cell, just as on earth. However, there were small, though statistically significant increases in irradiation sensitivity in immature cells. Gene and chromosome damage in adult flies was increased, and the numbers of stumpwing mutant Drosophila were increased. There were 14 mutants in 20,652 flies in space as compared to 4 out of 24,838 on earth. The rate of recessive lethal mutations was 5.1% as compared to 3.3% on earth. The gene exchange between X and Y chromosomes was 42/17,000 organisms as compared to 12/17,000 on earth. In Tribolium, lethal mutations were doubled. Over 45% developed radioinduced flight anomalies as compared to 30% on earth. The Habrobracon were more resistant to irradiation and recovered from irradiation injuries more rapidly than the other organisms. Egg production in female animals was reduced during the first 10 days of the flight. One strain of irradiated Salmonella grew more slowly in space than on earth. Growth of Escherichia coli was increased by 20%. (BBB)

21120 CYTOLOGICAL STUDY OF DIFFERENCES IN THE RADIOSENSITIVITY IN OUTBRED, INBRED, AND HYBRID MICE. Ronichevskaya, G. M. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika; 5: No. 12, 76-82(Dec 1969). (In Russian).

The mutability (induced by 100 R) of blood-forming cells in outbred, highly inbred ($CC_{57}Br$, $C_{57}Bl$, AKR, $A/_{HC}$ and $C_3H/_{HC}$), and hybrid 2-months-old mice was assessed by the number of bridges and fragments at the anaphase and telophase stage. In all the inbred strains the frequency of the induced chromosome changes was much higher than in the cells of outbred mice and correlated with values defining the total radiosensitivity of the organism. The frequency of induced chromosome aberrations in bone marrow cells in all investigated hybrids: F_1 (outbred mice × A), F_1(AKR × $C_{57}Bl$), F_1(AKR × $CC_{57}Br$), F_1($CC_{57}Br$ × outbred mice) and F_1(A × $CC_{57}Br$) was either intermediate as to both parents or exceeded that of parents. At the same time, 24 hr after irradiation, a considerably smaller number of chromosome injuries was found in bone marrow cells of the same hybrids than in their parents. The study of the effect of 100 R at different periods after irradiation

showed that cytogenetic differences in radiosensitivity of hybrids and their parents are connected not with primary irradiation injury of genetic structures but with the peculiarities of their reparation processes that normalize the deranged functions of the organism in a shorter time than in inbred and outbred mice. Perhaps rapid reparation of irradiation injury in hybrids is one of the mechanisms of heterogenesis. (auth)

21121 THE COMPARATIVE ANALYSIS OF THE SPECTRUM OF CHROMOSOME ABERRATIONS INDUCED BY X-IRRADIATION IN MAMMALIAN CELLS IN VIVO AND IN VITRO. Elisova, T. V. (Inst. of Developmental Biology, Moscow). Genetika; 5: No. 12, 42-8(Dec 1969). (In Russian).

The spectrum of aberrations in the cells of bone marrow of mice in vivo was found to correspond to the spectrum of other mammalia in vitro. The characteristic feature of the spectrum is the predominance of single chromatid-type deletions over other kinds of aberrations. Among iso-chromatid deletions observed, a very low level of sister joinings was found. The fact confirms qualitative differences of the reaction of plants and mammalia to irradiation. In contrast to animals, in plant cells iso-locus deletions with high level of sister joinings is the predominant type of aberration at the corresponding stages of the mitotic cycle. It was also revealed that the process of formation of aberrations was a prolonged one. Formation of the aberration (50 R dose) takes not less than 30 minutes. (auth)

21122 ULTRAVIOLET-MICROBEAM IRRADIATION OF NEWT-CELL CYTOPLASM: SPINDLE DESTRUCTION, FALSE ANAPHASE, AND DELAY OF TRUE ANAPHASE. Zirkle, Raymond E. (Univ. of Chicago). Contract AT(11-1)-946. Radiat. Res.; 41: 516-37(Mar 1970).

Mitotic tissue-culture cells of the newt Triturus viridescens were irradiated in various cytoplasmic regions with monochromatic or heterochromatic ultraviolet microbeams (conical, with 25° half-angle, 8 μ in diameter in focal plane). Depending on exposure, some spindles were destroyed (i.e., true anaphase was prevented), and this was sometimes followed by quasirosette formation and false anaphase. Efficiency of spindle destruction was not detectably affected by the presence of a centrosome or part of the formed metaphase spindle in the irradiated region. For 280-nm irradiation, the exposure that destroyed 50% of spindles was 2×10^{12} in terms of incident photons per cell times the cell depth in microns. Direct irradiation of centrosomes did not impair their mutual attraction for kinetochores. In metaphase-irradiated cells that survived spindle destruction, delay of true anaphase was critically dependent on whether irradiation occurred before or after the arrival of the last kinetochore at the spindle equator, the delay being significantly longer in the latter situation. (auth)

21123 DISTRIBUTION OF RADIATION-INDUCED BREAKS IN THE SEX CHROMOSOMES OF MICROTUS AGRESTIS. Schneider, G.; Waldenmaier, C. (Univ., Frieburg i. B.). Humangenetik; 8: 230-41(1969). (In German).

Fibroblast cultures from male and female field voles, Microtus agrestis, were exposed to an x irradiation of 250 R in order to obtain data on the distribution and frequency of radiation-induced chromosome aberrations in eu- and heterochromatin, especially under the aspect of selection over a longer period of observation. The cultures were harvested between 12 hr and 42 days after exposure. Chromosomal aberrations, such as dicentrics, rings, and deletions, were observed in the following frequencies: 12 hr after irradiation 31.5% in female and 25.9% in male cultures against only 1.9% in the control cultures. Further observation exhibited a slow decrease in the percentage of aberrations. The localization of the breaks (deletions) 12 hr after irradiation showed an approximately random distribution over the whole chromosome. At the later observation period the development of breakage maxima on some chromosome parts was observed. Compiling the breaks in the euchromatic and heterochromatic regions respectively, a breakage ratio of 1:3 was observed 12 hr after irradiation; this, when related to equal proportions of chromosomal length, corresponded again to a random distribution. At the later observation period cells with breaks in the euchromatin disappeared much faster than cells damaged in the heterochromatin, which altered the breakage ratio in favor of the heterochromatin. At 42 days after irradiation, the female showed a ratio of 1:4.5 (again related to equal parts of chromosomal length); the male showed a ratio of 1:5.7, 23 days after irradiation. This selective advantage of cells with chromosome breaks in the heterochromatin over cells damaged in the euchromatin confirms the hypothesis, that loss of heterochromatic portions of a chromosome must not lead to impairment of cell growth, i.e., the heterochromatin plays only a subordinate role in the cell function. (auth)

21124 UV-INDUCED MUTAGENESIS IN BAC. SUBTILIS STRAINS WITH DIFFERENT UV-IRRADIATION AND TRANSFORMABILITY. Likhoded, L. Ya.; Kiryushkina, A. A. Zh. Mikrobiol., Epidemiol. Immunobiol.; No. 12, 5-7(1969). (In Russian).

The incidence of spontaneous and uv mutations in streptomycin locus of different strains of Bacillus subtilis was studied. Mutation incidence proved to be increased in hcr-9 strains which had lost the ability to excise pyrimidine dimers. In recombination-deficient strain (MC-1) with reduced transformability, the incidence of mutations, spontaneous and induced by low uv radiation doses, showed a slight increase. However, the maximum mutation frequency in recombination-deficient strains was less than in bacteria of a wild strain. It is suggested that mutagenesis is related to some processes required for recombinations. (auth)

21125 RADIATION INDUCED CHLOROPHYLL MUTATIONS IN RICE. Basu, A. K.; Basu, Rabindra Krishna (Bose Inst., Calcutta). Indian J. Genet. Plant Breed.; 29: 353-62(Nov 1969).

Chlorophyll mutations comprising of albina, xantha, virescent and rare types like striata, chlorina and lutescent occurred in M_2 generation after treatment of seeds with x rays, ^{32}P, and ^{35}S, and in M_3 generation after chronic γ irradiation of plants of three varieties of winter rice. Within the range of dosages applied, the mutation rate in general increased with increase in radiation dosages excepting in ^{32}P and ^{35}S when dosages above 8 μCi/seed produced a decline in mutation rate. A comparison of the mutagenic effects of x rays, ^{32}P, and ^{35}S revealed that ^{32}P and ^{35}S were more mutagenic than x rays. Again, ^{32}P was found to be more mutagenic than ^{35}S. The mutation spectrum varied after treatment with different ionizing radiations. Compared to ^{32}P and ^{35}S, x rays produced relatively more of albina and virescent and less of xantha. Sulfur-35 induced more rare-type mutations than x rays and ^{32}P. Albina was more frequent than xantha or virescent after exposure of plants to a number of dosages of ^{60}Co γ rays. Irrespective of the mutagens used, albina occurred in maximum frequency, followed by virescent, xantha and rare types. (auth)

21126 INHERITANCE OF X-RAY INDUCED VIRESCENT MUTANT IN GROUNDNUT. Patil, S. H. (Bhabha Atomic Research Centre, Bombay). Indian J. Genet. Plant Breed.; 29: 387-94 (Nov 1969).

Critical understanding of genetic behavior is better accomplished by studying a variety of cross-combinations (Hammons, 1964). Accordingly, the virescent x-radioinduced (v) mutant of groundnut was crossed to four distinct genotypes. The results indicated its monogenic relation with the Spanish parent and darker green (dr) and impairpinnate (imp) mutants, and a digenic relationship with the large pod (Lp) mutant. Based on the segregant types in F_2 the following genotypic composition of parents and F_1s may be suggested. While epistatic effects apparently controlled the darker green expression in the dr mutant, additive action accomplished the same in large pod mutant. The genetic behavior of imp character appeared to be simple and was independent of v. In spite of the low frequency of imp type plants in the heterozygous progenies, the segregation pattern was consistent. Therefore, this mutant character in addition to virescent can be utilized as genetic marker in breeding experiments. (auth)

21127 THE USE OF SEX-CHROMOSOME ANOMALIES FOR MEASURING RADIATION EFFECTS IN DIFFERENT GERM-CELL STAGES OF THE MOUSE. Russell, Liane B. (Oak Ridge National Lab., Tenn.). pp 27-41 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Several types of anomaly that would be lethal if they involved autosomes can be recovered in viable offspring if the chromosomes affected are the X and/or Y. Marker systems have been developed for recognizing a high percentage of the possible anomalous types that would result from non-disjunction, monosomy, deficiency, and perhaps, certain rearrangements. Because sex-chromosome anomalies are thus especially suitable for studying effects of radiation and other mutagens, we have used them in extensive comparisons of various germ-cell stages in the mouse, including meiotic systems. No good evidence has been obtained for x-ray induction of non-disjunction. On the other hand, the XO phenotype is easily produced. The great majority of these cases is the result of simple monosomy, but a few "XO" animals have also been observed that probably carry sex-chromosome deficiencies or, perhaps, other aberrations. By far the highest yields of sex-chromosome losses are obtained by irradiating zygotes, from the time of sperm entry (second meiotic division) through early pronuclear stage. X^M may be relatively more sensitive than X^P or Y during the first part of this period; and there is reason to think that OX^P yield for irradiation metaphase-I of the female, when finally measured, may turn out to be even higher. There is a sharp drop in

sensitivity between early and later pronuclear stages. Among gonadal germ cells tested, the ones yielding the highest XO frequencies are the dictyate in mature follicles of the female, and the spermatid in the male. Leptotene-through-diplotene oocytes, and spermatocytes, taken as a group, give a lower, and roughly equal, yield. Among spermatocytes, post-pachytene stages give the lowest frequency of XO. These comparisons must, however, take account of the fact that XO yield from irradiation of spermatocytes and predictyate oocytes is presumably being measured in selected cell populations. The factors that determine differential sensitivity are probably manifold and complex. It is very likely that they vary from one comparison to the next. (auth)

21128 INDUCED MUTATIONS AND LETHALITY IN DROSOPHILA AFTER X-IRRADIATION OF MEIOTIC AND POST-MEIOTIC STAGES OF THE EGG. Wuergler, F. E. (Swiss Federal Inst. of Tech., Zurich). pp 43-62 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

In radiobiological experiments with new-laid eggs and young embryos of Drosophila melanogaster the role of nuclei and chromosomes in radiation-induced death was analyzed. The predominant role of the nuclei was demonstrated by means of partial irradiation of uncleaved eggs that showed that the region of highest radiosensitivity corresponds with the region containing the nucleus. This was further corroborated by the findings that radiosensitivity can be correlated with the nuclear division stage and the number of nuclei present at the moment of irradiation. The correlations with nuclear division stages are different for induced lethality and for specific types of mutations (sex-linked lethals and reciprocal translocations). Assuming that chromosomal damage is an important factor in radiation-induced lethality, it was postulated that other types of chromosomal changes contribute also to lethality, e.g., induced breakage-fusion-bridge cycles, with still another correlation with nuclear division stages. Preliminary results on the radiosensitivity of different genotypes indicate that the above assumption can probably be tested experimentally. (auth)

21129 NON-DISJUNCTION AND ISOCHROMOSOMES FROM IRRADIATION OF CHROMOSOME 2 IN DROSOPHILA. Bateman, A. J. (Paterson Labs., Manchester, Eng.). pp 63-70 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Using a stock of Drosophila in which chromosome 2 is represented as two isochromosomes, a study has been made of the induction of non-disjunction (and loss) of chromosome 2 in ♀♀ by x rays. At the same time it was found that there was a high yield (one quarter of all progeny) of induced isochromosomes. There is a high yield of all classes of progeny from irradiated oocytes and a lower yield from irradiated oogonia and stem cells. The fractionation of the progeny into the various classes is independent of the stage of oocyte. Oogonia give relatively few nullisomic progeny when compared with oocytes. Ninety percent of the disomic progeny from oocytes arise from first division non-disjunction. There is evidence that at second division the disjunction of the two half-bivalents is not random. Most of the disomic progeny from oogonia have arisen via asynapsis which, paradoxically, is accompanied by increased crossing over in the normal progeny. Phenotypic analysis of the isochromosomes shows that one quarter contain sister centromeres compared with the expectation, with random association, of one third. The mode of origin of isochromosomes, and its relevance to sister strand exchange in meiosis, are discussed. The ease of reconstruction of normal chromosomes also has bearing on their mode of origin. (auth)

21130 RADIATION EFFECTS ON GENETIC RECOMBINATION IN CHLAMYDOMONAS REINHARDI. Lawrence, C. W. (Wantage Research Lab., Berks, Eng.). pp 135-44 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Low doses (up to 8 kR) of ^{60}Co gamma radiation influence recombination in Chlamydomonas reinhardi at only two short stages during the course of meiosis. Stage 1, during which the frequency of recombination is decreased, occurs in preleptotene and lasts for 10 to 15 min. Recombination frequency is increased at Stage 2, which occurs in pachytene and is probably of similar duration to Stage 1. Higher doses of gamma radiation decrease recombination frequency at all stages up to pachytene. The response to 3.2-MeV alpha particles appears to a combination of the responses typical of both low and high doses of gamma radiation. High RBE's are found for each kind of response, especially that typical of high doses of gamma radiation. The target for the high-dose type of response is entirely unknown. Those for the two low-dose types of response appear to be associated with DNA, and more specifically with DNA synthesis. From the genetical point of view the data suggest that both gene and allele recombination take place in two steps, with the terminal step occurring at pachytene. The two kinds of recombination have a common involvement in DNA synthesis, but are essentially different processes. (auth)

21131 THERMAL NEUTRON SENSITIVITY OF VICIA FABA MEIOSIS. Ecochard, R. M. (Association EURATOM-ITAL, Wageningen, Netherlands). pp 145-9 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

The α-particles ejected by the stable isotope ^{10}B (20% of the natural boron) under thermal neutron irradiation account for an important part of the damage observed in exposed cells. This contribution can easily be analyzed by introducing differently enriched boric acid samples into the nutrient medium where plants are grown. The sensitivity of irradiated male Vicia faba meiotic chromatids at leptotene was studied. An analysis of the various components of the absorbed dose related to the frequency of observed damages made it possible to estimate the RBE of internally produced α-particles under these conditions. The discrepancy of the value found, 2.18, from the RBE usually calculated for external α-irradiation is tentatively explained by a non-homogeneous distribution of the boron element in the cell and the assumption that it is preferentially located at the periphery of the cell. This hypothesis agrees with what is known of the role of boron in the cell physiology. (auth)

21132 SQUASH PROCEDURE FOR HANNCHEN BARLEY (HORDEUM DISTICHUM L.). Campbell, W. F. (U. S. Dept. of Agriculture, Fort Collins, Colo.). pp 163-6 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Advantages of the Hannchen variety of barley for radiation studies are discussed and conditions for growing the plants are described. The squash procedure is used for studying the effects of radiation on meiosis of pollen mother cells. The technique for this procedure is outlined including preparation of slides, determining the desired stage, fixation, preparing the smears, and making the slides permanent. (H.L.W.)

21133 TECHNIQUES FOR STUDYING THE EFFECTS OF RADIATION ON MEIOSIS AND RELATED PROCESSES IN MOSQUITOES WITH PARTICULAR REFERENCE TO AEDES AEGYPTI. Rai, K. S. (Univ. of Notre Dame, Ind.). pp 185-200 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Procedures for rearing more than 100 strains of Aedes aegypti in the Mosquito Genetics Project are discussed. Sources of radiation are a 10 kCi ^{60}Co source and a 260 kVp Picker Therapy x ray machine. Various immature and mature stages of the mosquito are exposed to 500 to 64,000 R for studies on the meiotic and mitotic cycle, oviposition and egg hatchability, rate of growth and development, viability to adulthood, longevity, and reproductive capacity. This establishes sterility doses and relative radiosensitivities of various stages. Procedures for using the squash technique for the study of chromosomes are described. Squash preparations of testes from larvae, pupae, and adults are described for studies on meiosis and spermatogenesis. Whole mounts of ovaries are made for studies on oogenesis. Cytogenetic techniques for isolating specific chromosomal aberrations, such as reciprocal translocations, paracentric inversions, and trisomy, are described. A technique for detection of radioinduced sex-linked lethal mutations is explained. Hybrids of crosses between inbred strains of Aedes aegypti showed a marked resistance to radiation; it is suggested that heterosis contributes to radiation protection. (H.L.W.)

21134 METHODS FOR RADIATION STUDIES DURING OOGENESIS IN HABROBRACON JUGLANDIS (ASHMEAD). Whiting, Anna R.; Smith, R. H.; Von Borstel, R. C. (Oak Ridge National Lab., Tenn.). pp 201-8 of Effects of Radiation on

Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Techniques of handling eggs and larvae and methods of classification of death of larvae and pupae are described. After ten days from the beginning of the experiment, the surviving adults are anaesthetized by carbon dioxide, observed for visible mutations, and recorded as surviving adult males and females. Techniques for separating meiotic stages by timed intervals of egg laying are discussed. When females are irradiated, clusters of eggs are laid which, by accurate timing, can be placed in homogeneous categories of oocytes irradiated in the first meiotic metaphase, diakinesis, and the earlier first meiotic prophase stages. Mutagenesis is discussed with regard to dominant lethality, recessive lethal mutations, inherited partial sterility, visible mutations, and sterility. Sensitivity of various mitotic stages to x radiation is discussed. (H.L.W.)

21135 A SURVEY OF METHODS FOR THE INDUCTION OF ABERRATIONS IN MEIOTIC STAGES IN DROSOPHILA FEMALES AND FOR OBSERVATION OF THEIR DISJUNCTIONAL PROPERTIES IN THE ENSUING MEIOTIC DIVISIONS. Parker, D. R. (Oak Ridge National Lab., Tenn. Univ. of California, Riverside). pp 209-18 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Methods of obtaining uniform samples of single meiotic stages of oocytes and of determining sensitivity of meiotic stages of oocytes to various doses of radiation are described. Detection of aberrations following irradiation are discussed with regard to detachment of attached-X females, X-Y exchange, X-4 exchange, X deletion, X-major autosome exchange, detachment of reversed acrocentric compound X's, Y chromosome fragments, Y-4 exchange, nonreciprocal interarm exchange, exchange with X, autosomal tip exchange, tandem duplications and translocations, and disjunction following formation of aberrations. Partial recovery of translocations involving major autosomes and meiotic exchange as a method of genetic analysis are discussed. (H.L.W.)

21136 RESPONSE OF DIFFERENT GENOTYPES OF TRITICUM AESTIVUM SSP. VULGARE TO MUTAGENIC TREATMENTS. Borojevic, Katarina; Borojevic, S. (Faculty of Agriculture, Novy Sad, Yugoslavia). pp 15-46 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Several varieties of Triticum aestivum ssp. vulgare were chosen to study the response of different genotypes to irradiation. The analysis through generations was performed on seven varieties representing entirely different genotypes and divided in three experiments according to the year and type of treatment. The results show that irradiation by thermal neutrons, x rays and γ rays results in a decrease in the mean value of quantitative characters in the M_1 generation. The mean values increase sharply in M_2 compared with M_1, but are still below those of control. In M_3 a slight decrease was observed, in the M_4 a stagnation, and in M_5 the mean values are around those of control in all genotypes. If the individual genotypes are considered in which the mean has reached or exceeded the mean of the control in the M_4 and M_5, it was very difficult to see the response of different genotypes. In general, all genotypes react in the same way. The specific response to mutagenic treatments was not found in the studies of the quantitative characters of the seven high selected varieties of Triticum aestivum vulgare, in later generations. (auth)

21137 MUTATION BREEDING IN VEGETATIVELY PROPAGATED CROPS. Broertjes, C. (Inst. for Atomic Sciences in Agriculture, Wageningen, Netherlands). pp 59-62 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Mutation breeding in vegetatively propagated crops has assumed fairly large proportions in the Netherlands because of the economical importance of such generally heterozygous plants as well as the great potential use of this method with them. Almost 50% of the total 1965 production value of agricultural and horticultural crops in the Netherlands came from vegetatively propagated plants (potato, fruit, ornamentals) and in other parts of the world many important crops belong to such plants (potato, sugar cane, sweet potato, cassava, various fruits). A discussion of vegetatively propagated crops in general, is presented with details of mutation breeding results in Dahlia variablis. (auth)

21138 GENETIC NATURE OF DOMINANT AND RECESSIVE SUPPRESSOR MUTATIONS IN BARLEY. Tuleen, N. A.; Caldecott, R. S.; Snyder, L. A. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-332. pp 73-6 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

A large number of phenotypic reversions of a yellow virescent mutant in barley were induced with ionizing radiations and chemical mutagens. Forty-four of them were studied genetically. The 25 induced with ionizing radiations are recessive suppressors, whereas the 19 induced with chemicals consist of both dominant and recessive suppressors. Three of the dominant reversions that were induced are allelic to or closely linked to the yellow virescent locus. It was not possible to determine whether or not they are true back mutations or dominant suppressors. (auth)

21139 YIELD ANALYSIS AFTER REPEATED MUTAGENIC TREATMENT AND SELECTION IN BARLEY. Gustafsson, A.; Lundqvist, Udda; Ekman, G. (Royal Coll. of Forestry, Stockholm). pp 113-28 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Grains were treated for 1 or 2 or 3 years, in 1960 to 1962, either singly with neutrons (N) or ethyl methanesulphonate (E) or with combined treatments EN, NE, ENE, NEN. Simultaneously, a series with untreated and unselected (C) populations was used: EEC, EC, ECC, NN, NC, NCC, and all were compared with intensely selected controls in two varieties. M_5 and M_6 tests (1966 and 1967) were made identically at Svalöf and at Risö. Measurements included fertility, chlorophyll mutations, and these components of grain yield: grams per row, yield per plant, spikes per row, spikes per plant, and plants per row, and interaction of these components with location. N treatments gave rise to selections definitely superior to E treatments; combining N and E gave no advantage. (auth)

21140 GENETIC STUDIES ON SHORT-GRAIN MUTANTS IN RICE. Kawai, T. (National Inst. of Agricultural Sciences, Hiratsuka, Japan). pp 161-82 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Four radioinduced and one spontaneous short-grain mutations of a rice variety were genetically studied. Crosses between the original variety and the mutants and also between mutants (nine out of a possible ten crosses) were made and segregations of grain shape and other characters were investigated in the F_2 to F_3 generations. In crosses between mutants, the characteristics of double-homozygous types were investigated in comparison with those of the original variety and the parent mutants in F_6. The results obtained were as follows: F_1 plants in all tested crosses were normal in fertility. No conspicuous difference was observed between F_1 plants in reciprocal crosses between mutants and the original variety. The five mutant strains each carry one single gene for short-graininess, and at least the four mutant genes are located in different loci. The genes of the original variety are not completely dominant to the mutant genes. The mutant genes show pleiotropic effects on culm length, panicle length, panicle density and other characters. None of the mutant genes was completely epistatic to the other genes. Interactions of the mutant genes were productive in many gene combinations and characters, but were more than productive in a considerable number of cases. Character-specific and/or gene-combination-specific interactions were observed. (auth)

21141 SELECTION EXPERIMENTS IN A POPULATION OF TRITICUM DURUM IRRADIATED WITH X-RAYS. Scossiroli, R. E. (Univ., Bologna). pp 205-17 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Selection experiments were performed on a population of Triticum durum, var. Cappelli maintained under self-fertilization after x-ray treatment (10,000 R) applied to the seeds, and on a control population. Family selection (20% pressure) and mass selection (20 and 10% pressures) were started from the R_2 and from the R_3 generations. Selection was made for plant height, number of stems, number of spikelets in the main spike and number of seeds in the main spike, with the aim of increasing or decreasing (disrupting selection) and maintaining the average of the population (stabilizing selection). While no response was found in the control population,

definite responses were obtained from the irradiated population; mass selection at the 10% pressure was the most efficient. Radiation treatments applied to seeds were thus shown to be a powerful tool for inducing responses to selection in a variety of durum wheat, a self-fertilized plant, that does not respond to the same selection performed without radiation. (auth)

21142 STUDIES ON THE ENHANCEMENT OF MUTATION FREQUENCY AND IDENTIFICATION OF MUTATIONS OF PLANT BREEDING AND PHYLOGENETIC SIGNIFICANCE IN SOME CEREALS. Swaminathan, M. S.; Siddiq, E. A.; Savin, V. N.; Varughese, G. (Indian Agricultural Research Inst., New Delhi). pp 233-49 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Comparative studies on the frequency and spectrum of mutations induced by physical mutagens like x rays, γ rays and fast neutrons and chemical mutagens like ethyl methanesulfonate (EMS), nitroso methyl urea (NMU) and N-methyl-N^1-nitro-N-nitroso-guanidine (NG), in several varieties of barley, rice and bread wheat showed that both the frequency and spectrum are enlarged in the chemical treatments. Both NMU and NG are more potent in rice and barley than EMS. The efficiency peak of NMU remains the same as in EMS, both being most effective when the treatment is given in the S phase of DNA duplication. The size of the mutated sector in barley is increased with the NMU treatments, while in rice it is increased with NG treatments. Unlike in the case of radiation treatments, dose did not affect the number of cells involved in the ontogeny of the spike in EMS treatments. Both NMU and NG qualify to be termed under the super mutagen class of Rapaport. EMS induces mutations for grain shape and quality in rice more readily than radiation. Both protein and amylose content can be manipulated and the induced mutants have provided a better understanding of the mechanism of sub-specific differentiation in Oryza sativa. Grain color and the quantity and quality of proteins in bread wheat lend themselves to mutational manipulation. Here again, EMS seems to be more potent than γ rays. There is great scope now for producing varieties of cereals combining a high yield potential with a high protein quantity and quality. A wheat variety developed by mutation breeding named Sharbati Sonora was released for cultivation in India in May 1967. This variety differs from the parent strain Sonora 64 in having amber grains, a higher protein content and loaf volume and more lysine per 100 g of protein. (auth)

21143 FIRST-YEAR RESULTS IN THE FAO/IAEA NEAR EAST UNIFORM REGIONAL TRIALS OF RADIO-INDUCED DURUM WHEAT MUTANTS. Tessi, J. (FAO, Rome); Scarascia-Mugnozza, G. T.; Sigurbjoernsson, B.; Bagnara, D. pp 251-72 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

With the aim of obtaining mutants of both theoretical and practical interest, experiments with the artificial induction of mutations were carried out in the past few years at the Laboratorio per le Applicazioni in Agricoltura of the Italian National Committee for Nuclear Energy, at Casaccia Centre, on some of the best cultivated Italian durum wheat varieties. Among these are Cappelli, Russello, Aziziah, Grifoni and Garigliano. Many of the mutations obtained were evaluated agronomically in a number of trials, performed in different years and locations in Italy. Some of the mutants gave good results as far as lodging resistance and yielding ability are concerned. In 1965, it was decided to try them over a wider area in a series of trials within the framework of the FAO Near East Project for Wheat and Barley Improvement, under the auspices of FAO and IAEA. In 1965 to 1966, 14 trials were performed, and data were obtained from 11 of them. The results obtained are reported. (auth)

21144 MUTAGEN SPECIFICITIES OF 44 ECERIFERUM LOCI IN BARLEY. von Wettstein, D.; Lundqvist, Udda; von Wettstein-Knowles, Penny (Univ., Copenhagen. Royal Coll. of Forestry, Stockholm). pp 273-6 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

The mutagen specificities of 44 eceriferum loci in barley were analyzed. The mutagens employed were ionizing radiations, ethyleneimine and sulfonates. (F.M.M.)

21145 LIFETIMES OF RADIATION-INDUCED OXYGEN-SENSITIVE CENTRES IN BARLEY EMBRYOS SOAKED AT DIFFERENT TEMPERATURES. Ahnstroem, G. (Joint FAO/IAEA Div. of Atomic Energy in Food and Agriculture, Vienna); Mikaelsen, K. pp 283-6 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Barley seeds were γ-irradiated and soaked for various times in oxygen-free water at 0°C and 20°C before transfer to oxygenated water. The lifetime of the oxygen-sensitive centers in the embryos was studied by determining the seedling height reduction and frequency of chromosome aberrations. (F.M.M.)

21146 COMPARISONS BETWEEN CHROMOSOME ABERRATIONS INDUCED BY IONIZING RADIATIONS AND ALKYLATING AGENTS AT DIFFERENT STAGES OF MITOSIS IN BARLEY SEEDS. Mikaelsen, K. (IAEA, Vienna). pp 287-90 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Barley seeds were germinated, exposed to γ radiation and treated with chemical mutagens (EMS and DES). After the mutagen treatments germination was continued and roots were fixed at various times from 2 to 24 hours later. The effects of the treatments were studied on chromosome aberrations in anaphase of the root meristematic cells. By comparing the ionizing radiation and the alkylating agents at different fixation times after treatments, it appeared that the highest frequency of chromosome aberrations was obtained 4 hours after an exposure to γ radiation. For the alkylating agents the highest chromosome aberration frequencies were found 18 to 21 hours after the treatments. It was concluded from these experiments that by studying the sensitivity at different mitotic stages, G_2 was most sensitive to ionizing radiations while early G_1 showed the largest sensitivity to EMS and DES. In late G_2 and M almost no damages leading to chromosome breaks appearing in the first mitosis after treatment did occur. (auth)

21147 MUTATION EXPERIMENTS IN DURUM WHEAT. Nagl, K. (Federal Inst. for Crop Husbandry and Seed Testing, Vienna). pp 293-8 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Mutation experiments are being carried out with the durum wheat variety Adur. Some preliminary results on chlorophyll mutation and morphological mutation from DES and combined treatments of γ radiation and DES are reported. More material is needed to draw any definite conclusions with respect to the effectiveness of the various types of mutagen treatments. Some morphological mutants were selected which previously have not been reported in the literature from chemical mutagen treatments. (auth)

Health Physics and Safety

Refer also to abstract 21448.

Radioactive Contamination and Decontamination

Refer also to abstracts 20889, 21058, 21093–21095, 21097, 21099, and 21105.

21148 (GAT-606) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS SECOND HALF AND ANNUAL SUMMARIES, 1969. Kalmon, B.; Hulett, S. H. (Goodyear Atomic Corp., Piketon, Ohio). 6 Mar 1970. Contract AT(33-2)-1. 16p. Dep. CFSTI.

The average environmental radiation and concentration levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the second half of 1969 and for the calendar year 1969, are summarized. The results for the first half of 1969 were previously reported in GAT-605 but are also included in tabular form in this annual summary. For the second half of 1969, the water alpha, air alpha, air beta-gamma, and background exposure increased over the first half values. The water beta-gamma for the second half decreased compared with the first half value. For the calendar year 1969 versus calendar year 1968, all of the air and water values remained essentially unchanged. Penetrating background dose rates for 1969 are slightly lower when compared with the 1968 values. In the calculations, all of the exposure rates were assumed attributable to plant operations. As in the past, however, the off-site and on-site patterns are very much alike in form and intensity with no significant difference between average values. Based on the on-site and off-site intensities, it is evident that the plant operations have not added appreciably to the general background penetrating radiation. (auth)

21149 (IS–2260) SURVEY OF ENVIRONMENTAL RADIOACTIVITY, JANUARY 1–DECEMBER 31, 1969. Voss, Milo D. (Ames Lab., Iowa). Feb 1970. Contract W-7405-eng-82. 41p. Dep. CFSTI.

The environmental monitoring program of the Ames Laboratory of the USAEC for the Ames Laboratory Research Reactor (ALRR) is summarized. The environmental program consists of gross alpha and beta determinations of air, soil, vegetation, river water, ALRR outfall, bottom sediment, precipitation, well water, and pond samples. The ALRR reached full power as of 7/12/65. The ALRR had generated 70133 megawatt hours as of 12/31/68. A total 35276 megawatt hours was generated in 1969. The data indicate that the ALRR has not contributed a significant amount of radioactivity to the environment in the Ames area. The conclusion is reached that radioactivity levels recorded for environmental samples represent background conditions from atmospheric fallout and naturally occurring radioactivity. (auth)

21150 (SZS–13/69) DECONTAMINATION OF TEXTILE SAMPLES WITH SIMULATED COMMERCIAL DETERGENTS. Unger, H.; Richter, K. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Oct 1969. 24p. (In German). Dep. CFSTI (U. S. Sales Only).

Decontamination of textiles made of cotton or synthetic fibers mixed with viscose or wool was investigated. The samples, contaminated with a SiO_2–^{60}Co suspension, were decontaminated with simulated washing agents, the composition of which was similar to that of commercially available products. Neutral washing agents containing polyphosphate showed the best decontamination efficiency. Decontamination was most effective for textiles made of cotton or synthetic fabrics consisting of polyester/viscose or polyacrylnitrile/viscose. (auth)

21151 THE LEVEL OF RADIUM IN HUMAN BLOOD FORTY YEARS AFTER INGESTION. Lucas, H. F. Jr. (Argonne National Lab., Ill.); Marshall, J. R.; Barrer, L. A. Radiat. Res.; 41: 637-45(Mar 1970).

The concentration of radium in the blood of radium cases at long times after exposure provides a sensitive test of models of long-term retention. The modified power function retention model predicts that the radium-to-calcium ratio in the body will be the order of 100 times that in the serum at times greater than 20 yr after exposure. The radium content of whole blood, blood serum, blood cells, urine, feces, and body of four New Jersey radium cases was determined 40 yr after exposure. The ratio of Ra/Ca in the body to that in the blood in these four cases averaged about 100, with a range of about a factor of 5. The average rate of excretory plasma or serum clearance for these four cases was about 80 liters/day and the coefficient of radium excretion was 2.5 ± 0.9% yr. (auth)

21152 LEAK TESTING OF RADIOACTIVE SOURCES. Ashton, T. (Radiological Protection Service, Leeds, Eng.). Brit. J. Radiol.; 42: 945(Dec 1969).

It has been shown that a source capsule inside a container can be leaking when the outside of the container shows no sign of radioactive contamination. Suggestions were made for the procedure in examining sealed sources permanently installed in containers. (UK)

Dosimetry and Monitoring

Refer also to abstracts 20891–20893, 20956, 20975, 20976, 20989, 20993, 20995, 21022, 21057, 21063, 21100, 21152, 21246, 21312, 22036, and 22037.

21153 (BARC–408) DOSIMETRY OF THE GASTROINTESTINAL TRACT SUPERFICIALLY CONTAMINATED BY ALPHA AND BETA EMITTERS. Hukkoo, R. K.; Unnikrishnan, K. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 25p. Dep. CFSTI (U. S. Sales Only).

Maximum and average dose to the GI-tract contaminated superficially by ingested alpha and beta emitters were calculated using basic energy equations and geometric factors. Simple empirical relations, as a function of the particle energy and the radius of the GI-tract section, are proposed. The results are compared with the maximal limits given by ICRP. Depth doses for various beta energies were also calculated. (auth)

21154 (BRH/DEP–70-1) X-RAY EMISSION FROM COLD-CATHODE GAS DISCHARGE TUBES USED FOR EDUCATIONAL PURPOSES. Properzio, William S.; Woodcock, Ray C.; Heidersdorf, Sidney D. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Feb 1970. 40p. CFSTI.

A study undertaken by the X-Ray Exposure Control Laboratory to identify cold-cathode gas discharge devices used in educational institutions that may emit x radiation is described. The tubes were operated from various commercially available high voltage sources suggested by the manufacturer and were typical of those used in high schools. Radiation measurements were made on the cold-cathode x-ray tubes and other gas discharge devices which emit x rays. Based on these results, specific recommendations are directed to the science teacher utilizing the equipment, to distributors selling the equipment, and to state or local radiological health agencies. (W.H.K.)

21155 (CEA-R–3884) EVALUATION OF AN INDIVIDUAL NEUTRON IRRADIATION BY A STUDY OF ITS BIOLOGICAL EFFECTS. Ventadour, Jacques; Labat, Christiane; Chivot, Jean-Jacques (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Oct 1969. 15p. (In French). Dep. CFSTI (U. S. Sales Only).

When neutron irradiation of personnel occurs some victims may not be wearing dosimetric films. An attempt was made to estimate the dose received by measuring the gamma activity of the ^{24}Na produced by $^{23}Na(n,\gamma)^{24}Na$ activation of natural sodium in the organism. Anthropomorphic dummies were used to calibrate an anthropogammameter and a one-metre arc, and then these dummies were irradiated with a known neutron flux. Phosphorus-32 activation of the sulfur in the hair produced by the reaction $^{32}S(n,p)^{32}P$ was also measured. The irradiations were carried out in the presence of dosimetric films to establish a correlation between the induced activities and the doses received. In cases where the neutron flux is unknown, this method makes it possible to make an approximate estimation of the dose, and to rapidly sort out the victims as a function of the dose received. (auth)

21156 (CEA-R–3952) ASSESSMENT OF BONE MARROW INTERNAL EXPOSURE TO ^{90}Sr AS A FUNCTION OF AGE. Odievre, Monique; Mechali, David (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 30p. (In French). Dep. CFSTI (U. S. Sales Only).

Bone marrow exposure was considered as representative of the hazards following contamination by ^{90}Sr. The general method for assessing the exposure is presented as well as the evolution as a function of age of the values assumed by the different parameters used. Exposure following ingestion and via the respiratory tract are studied successively; in each case, permanent and short-time exposures are examined. In the case of a permanent exposure, the evolution of the dose rates is studied through the time as a function of the age at the exposure. The committed dose is investigated in the case of a short-time exposure. (France)

21157 (KFK–1073) THE AGE-DEPENDENT INHALATION DOSE FACTOR OF ^{131}I. Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct 1969. 31p. (In German). Dep. CFSTI (U. S. Sales Only).

To develop an age-dependent inhalation dose factor g of ^{131}I, data for the development of the dose factor and partial quantities of the dose factor, respectively, are investigated. The numerical data are submitted to critical examination and an age-dependent curve is obtained. Simplification provides a convenient use of these data and, finally, the following dose factors are recommended. Individual dose factor: 0–5 years, g = 1,500 (rem m^3/C sec); 5–15 years, g = 1,000 (rem m^3/C sec); and over 15 years, g = 600 (rem m^3/C sec). Population dose factor: g_p = 770 (rem m^3/C sec). (auth)

21158 (PRNC–132) EVALUATION OF HEALTH HAZARDS DUE TO UNINTENTIONAL IRRADIATION OF THE GONADS DURING ROUTINE ABDOMINAL X-RAY EXAMINATION OF MALE AND FEMALE PATIENTS IN PUERTO RICO. Report No. 1, Western Region. Gileadi, Michael (Puerto Rico Nuclear Center, [San Juan]). Aug 1969. Contract AT(40-1)-1833. 105p. Dep. CFSTI.

The average gonadal dose associated with a selected group of abdominal diagnostic x ray examinations in the Western Region of Puerto Rico during 1967 was evaluated. This selected group is shown in the professional literature to be responsible for about 85% of the irradiation dose received during abdominal x ray diagnostics. It was found that the mean gonadal dose per abdominal x ray examination in the Western Region during 1967 was 422.8 mrads; the corresponding mean ovarial dose was 583.1 mrads; and the corresponding mean testicular dose was 281.9 mrads. A series of dose measurements performed on a Rando Phantom indicate that covering the testes with a lead shield of 1 mm thickness will eliminate approximately 95% of the testicular dose. Previously published data indicate that accurate collimation will reduce the gonadal dose by a factor of approximately 2.5. (auth)

21159 LOW-DENSITY INHOMOGENEITY CORRECTIONS FOR 22-MV X-RAY THERAPY. Leung, Philip M. K.; Seaman, Barbara; Robinson, Peggy (Ontario Cancer Inst., Toronto). Radiology; 94: 449-51(Feb 1970).

Correction factors for low-density inhomogeneity in lung tissues for use in dosimetry of 22 mV x rays were derived, based on measurements made in a phantom constructed with Lucite as the tissue-equivalent material and cork as the low-density material. The radiation dose at various depths was measured using LiF capsules spaced at one cm intervals along the central axis of the betatron beam. Experiments were performed with various thicknesses of Lucite and cork. The findings showed close agreement between ratio-corrected values and measured dose at various depths. (C.H.)

21160 PILOT STUDY OF DOSE FRACTIONZATION IN CARCINOMA OF THE BASE OF THE TONGUE: UNINTERRUPTED VS. SPLIT-COURSE IRRADIATION. Marcial, Victor A.; Frias, Zenaida (Puerto Rico Nuclear Center, San Juan). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 30-6(Jan 1970).

A prospective study of four ^{60}Co γ dose fractionation regimes for advanced carcinoma of the base of the tongue is presented. The treatment categories were: uninterrupted irradiation with daily fractions of 170 R up to 6,000 R; uninterrupted irradiation with three fractions per week of 285 R up to 6,000 R; a split-course technique with daily fractions of 300 R up to 3,000 R, followed by a rest period of approximately three weeks, then a repetition of the initial irradiation; and a similar split-course technique with three fractions per week of 500 R each. Normal tissue reactions, completion of therapy, tumor response, and two year disease free survival are discussed. The results of this study favor the split-course technique with daily fractions of 300 R; however, the limited number of cases involved does not permit a valid conclusion. (C.H.)

21161 DOSE, TIME, VOLUME RELATIONSHIPS IN SQUAMOUS CELL CARCINOMA OF THE SUPRAGLOTTIC LARYNX. Shukovsky, Leonard J. (Univ. of Texas, Houston). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 27-9(Jan 1970).

Radiation dose response data are presented for 114 patients with squamous cell carcinoma of the supraglottic larynx. The data indicate that single dose of 1,900 rads is optimal for patients with T_2 and T_3 lesions. (C.H.)

21162 PATIENT DOSE CALCULATION. Hale, John (Univ. of Pennsylvania, Philadelphia). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 201-5(Jan 1970).

An attempt was made to develop a unified, logically consistent methodology for the basic x radiation dose calculations for therapy. (C.H.)

21163 FURTHER INVESTIGATIONS OF PHYSICAL ASPECTS OF MULTIPLE FIELD RADIATION THERAPY. Faw, Fred L.; Glenn, Dwight W. (National Cancer Inst., Bethesda, Md.). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 184-92 (Jan 1970).

Further investigations of γ radiation dose distributions in the junction volumes between contiguous fields in phantoms have shown that gaps calculated for use when treatments are delivered through unilateral adjacent fields are applicable to multifield techniques incorporating opposing fields. Using the concept of decrement lines described by Orchard, total junction doses may be increased in a controlled manner to compensate for increased treatment time to the junction volume. The dose distribution in the junction volume is compared with that along the central axis of the contributing fields for commonly used contiguous field combinations. (auth)

21164 EARLY CARCINOMA OF THE VOCAL CORDS. KILOVOLTAGE RESULTS; TELECOBALT 60 DOSIMETRY (A PRELIMINARY REPORT). Feder, B. H. (Veterans Administration Hospital, Long Beach, Calif. Univ. of California, Los Angeles); Schaeflein, J. W.; Stein, J. J. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 269-77(Feb 1970).

Kilovoltage therapy of 32 consecutive cases of carcinoma limited to one or both vocal cords, with no impairment of mobility, has resulted in the gross four year survival without disease of 88% of the cases. The field size description for telecobalt-60 units, although clearly set forth by the ICRU, may present the radiation therapist with unique difficulties. If one is to irradiate the volume of interest to within 90% of a desired dose, the location of the 90% isodose line becomes critical. The width of a nominal field (usually measured at the 50% isodose line as recommended by the ICRU) and the width of a dosimetric field that is measured at the 90% isodose line may differ by more than three cm for a small field. Therefore records of field size might give both the nominal and the dosimetric field size for each telecobalt-60 unit. Clinically, it appears desirable to measure telecobalt-60 fields for vocal cord cancer at the 90% isodose line. We prefer a 5 cm × 5 cm dosimetric field, at the 90% line. (auth)

21165 MOVING STRIP IRRADIATION IN THE TREATMENT OF EXTENSIVE NEOPLASTIC DISEASE IN THE CHEST. Mincer, F.; Botstein, C.; Schwarz, G.; Zacharopoulos, G.; McDougall, R. (Montefiore Hospital and Medical Center, Bronx, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 278-83 (Feb 1970).

Eighty-five patients with advanced primary or secondary pulmonary neoplasms were treated with moving strip irradiation to the mediastinum and one or both lungs. A symptomatic short term relief was produced in about 50% of patients with carcinoma of the lung. This technique may be of curative value in a small number of radiosensitive neoplasms such as testicular tumors, Wilms' tumor, and lymphomas. It should therefore be considered as a primary method of treatment in selected cases with disseminated pulmonary disease. (auth)

21166 QUANTITATIVE MEASUREMENT OF THE INCREASE IN DOSE ADJACENT TO VOIDS DURING IRRADIATION OF A LUCITE PHANTOM BY HIGH-ENERGY ELECTRON BEAMS. Starchman, Dale E.; Chao, Jen-hung (IIT Research Inst., Chicago). Radiology; 94: 451-2(Feb 1970).

The perturbation of dose distribution caused by small air cavities during high-energy electron beam therapy of human lungs was investigated using a Lucite phantom that allowed the diameter of the void to be varied from 0 to 10 inches. Dose measurements were made at a depth of $\frac{1}{4}$ inch from the surface. Data are presented on the void dose as a function of the void diameter. (C.H.)

21167 EXTERNAL BEAM TREATMENT-PLANNING WITH THE PROGRAMMED CONSOLE. Holmes, William F. (Washington Univ., St. Louis). Radiology; 94: 391-400(Feb 1970).

A small computer system, the Programmed Console, was designed to calculate and display isodose distributions derived from multiple external γ beams. A set of programs was designed that calculate and display isodose distributions. Patient contour and beam information are stored on magnetic cards and used as input to the program. In general, single beams are in error less than one per cent of the maximum dose along the central axis and less than 2 mm in the penumbra. Multiple-beam distributions compare well with hand-calculated ones. The system is now in clinical use for external beam treatment planning. (auth)

21168 DOSE DISTRIBUTION IN THE ELECTRON BEAM FOR IRRADIATION AGAINST ORGANISMS. Sakka, Masatoshi; Inomata, Tsuyako (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 148-9(Jun 1969). (In Japanese).

The strength and the diffusion of electron beams for irradiation of organisms were measured. In the beam three lead blocks (20 × 20 × 5 cm) were put parallel to the irradiation opening (20 × 20 cm) at intervals of 5 cm, and one block was put out of beam. Electric current induced by the irradiation in the blocks was measured. It was proven that almost all amounts of electron rays were absorbed into the nearest block from the irradiating opening and quantities of the rays permeating through the block were negligible. But considerable amounts of electrons escaped out of the 20 × 20 cm beam. Geometrical distributions of strength of electron beams were detected by measuring radioactivities induced on a copper plate by beams. (NSA of Japan)

21169 FIRST EXPERIMENTS WITH ROENTGEN RADIATION OF CHRONIC JOINT INFLAMMATIONS IN DOGS. Hartung, K.; Clauss, W. (Freie Univ., Berlin). Berlin. Muenchen. Tieraerztl. Wochenschr.; 80: 295-7(1967). (In German).

Five cases of chronic joint inflammation in dogs, which were resistant to therapy are described. The dogs were given radiation in 3 to 4 fields with a total dose of 450 R to 600 R. In all cases an extensive recovery of freedom of movement was achieved. (auth)

21170 A NEW CALCULATION OF DOSE RATES FROM HIGH ENERGY ELECTRONS AND PHOTONS INCIDENT ON 30 cm WATER SLABS. Beck, H. L. (Atomic Energy Commission, New York). Nucl. Instrum. Methods; 78: 333-4(1970).

Dose rates are calculated, accounting for the density effect correction to the electron stopping power. Lower values are obtained than heretofore reported. (auth)

21171 A REVIEW OF THE INTERNATIONAL ATOMIC ENERGY AGENCY'S ACTIVITIES IN RADIATION DOSIMETRY. Moos, Walter S.; Eisenlohr, H.; Balamutov, V.; Jayaraman, S. (IAEA, Vienna). Strahlentherapie; 139: 100-8(Jan 1970).

Activities of the IAEA in radiation dosimetry are reviewed. Methods for improving the function of IAEA are discussed. Suggested are: preparation of a basic manual of dosimetry in radiotherapy, the setting up of regional dosimetry facilities, and the establishment of national laboratories for standardizing radiation measurements. (H.B.G.)

21172 QUOTIENT BETWEEN ENERGY FLUX AND ION DOSES AS A CHARACTERISTIC OF X RADIATION. Drexler, Guenter; Gossrau, Manfred; Nahrstedt, Uve (Institut fuer Strahlenschutz, Munich). Strahlentherapie; 139: 109-12(Jan 1970). (In German).

The quality of a Roentgen beam is exactly described by the spectral photon flux. This description however is not appropriate for medical practice; this spectrum consists of a large number of values and cannot be simplified. With the aid of several measurements and by hand of an example it is shown that the energy dose or the energy flux can be derived from the ion doses or the quotient erg · cm^{-2}/R. The mean energy, derived from this ratio is a good value to characterize the radiation beam in diagnostic range. (auth)

21173 STUDY OF THE PLASMA UPTAKE OF LABELLED VITAMIN B_{12}. Pierotti, Th.; Bajard-Pellotier, F. (CAC, Nice). Rev. Fr. Etud. Clin. Biol.; 14: 602-6(Jun-Jul 1969). (In French).

The test of ^{57}Co-labeled vitamin B_{12}, when the quantity is determined in the blood, has a clear advantage over the Schilling test because it does not require the cooperation of the patient and does not depend on the perfect integrity of the urinary function. Moreover the irradiation of the liver is very slight. The results obtained differentiate very clearly a pernicious anemia from every other anemia and from different malabsorptions of vitamin B_{12}. (auth)

21174 CHANGES IN ACUTE RADIATION HAZARDS ASSOCIATED WITH CHANGES IN EXPOSURE GEOMETRY. Clifford, C. E.; Facey, R. A. (Defense Research Establishment, Ottawa). Health Phys.; 18: 217-25(Mar 1970).

The ratios of the mean bone-marrow dose and of the midline abdomen dose to the corresponding exposures were measured for a phantom exposed in a rotational geometry about its vertical axis to broad beams of x and γ radiation incident at angles from −30° to +75° to the normal to the axis of rotation. The energy of the radiation varied from 0.06 to 0.66 MeV. The ratio of the dose to the exposure was heavily dependent on the irradiation geometry. For many exposure conditions it was shown that the ratio of dose to exposure obtained at normal incidence would not be sufficient to assess the hazard for acute effects of whole-body irradiation. (auth) (UK)

21175 EXPOSURE TO IONIZING RADIATION DURING DIAGNOSTIC PROCEDURES. Kunz, E. Cas. Lek. Cesk.; 108: 1089-92(Sep 1969). (In Czech).

The author discussed contemporary estimates of the hazard of late somatic and genetic health damage after exposure to small doses of ionizing radiation. He presents data on the frequency of X-ray examinations in Czechoslovakia and on the load associated with X-ray diagnosis which he characterizes in particular by the average genetically important dose of 33 mrad and the mean dose in the bone marrow (185 mrad) per head per annum. Despite the fact that the benefit from X-ray diagnosis for the health of the population is probably greater than the adverse sequelae, the present level of exposure cannot be considered acceptable as it is in extent excessive and can be reduced without diminishing the required information by readily implemented methods. (auth)

21176 COMPUTER SCIENCE AS APPLIED TO MODERN RADIATION THERAPY. Wallace, Keene M.; Fenn, Jimmy O. J. S. Carolina Med. Ass.; 65: 67-72(Mar 1969).

A system for computer calculations of radiotherapy dosimetry information was discussed. Its development, costs, and availability to peripheral medical centers were described. Several computer programs available for calculating the irradiation dose delivered with implantable isotopes were discussed. The computer program used was designed so that information for localization of the isotopes was obtained from either orthogonal or stereoscopic films. From this information the dose patterns were calculated. These provided dosimetric information such as the location of radioactive sources in the lesion, the type of sources used, and the shape and size of the sources and their intensity. The computer programs then calculated the dose from each point from an extremely large number of points, and added all these points together to produce a total dose delivered to the area of interest. The computer described certain dose levels at various points and the dose distributions in the volume of interest. In the computer system utilized and the computer programs developed, the detailed dosimetry of implantable sources was calculated and the results transmitted through telecopier hook-up. This program yielded a complete dosimetry record for an implantable source. The flow diagram showing how the dosimetry information was obtained by transmission from a remote computer center was presented. (BBB)

21177 EXTENDED PERIOD MONITORING OF X-RADIATION FROM ELECTRON MICROSCOPES. Ballance, P. E. (Univ. of East Anglia, Norwich, Eng.). Health Phys.; 18: 297(Mar 1970).

Radiation measurements obtained at chest height at various distances from an electron microscope operating at 30 kV and in which a metallic whisker had developed on one side of the filament wire are shown. When a new filament was fitted the exposure rate fell to 0.75 mR/hr near the surface of the electron gun container. It is pointed out that a short period radiation survey might not have detected the high exposure rate that had persisted for several hours. Manufacturers should be aware of the increased radiation likely from this condition and should ensure that the electron gun container is fitted with sufficient shielding to reduce external radiation to acceptable levels when operating with normal or whiskered filaments. (UK)

Radiation Protection

Refer also to abstracts 20959 and 21195.

21178 (AED-C-12-21) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 12. NUCLEAR SCIENCE LITERATURE OF EASTERN COUNTRIES. NUMBER 21. RADIATION PROTECTION. Ensslen, Benno (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Dec 1969. 199p. (In English and German). Dep. CFSTI (U. S. Sales Only). ZAED DM 12.

A list of 1127 references on radiation protection, which covers the period from 1967 through 1969, is presented. An author index is included. (W.H.K.)

21179 STUDY OF RADIOLOGIC ASPECTS CONNECTED WITH THE MANUFACTURE AND USE OF RADIOACTIVE LIGHTNING RODS. Delhove, J. J. Belge Radiol.; 52: II-VII(1969). (In French).

The radiological hazards associated with the fabrication and use of radioactive lightning conductors are reviewed. It would appear that the danger of irradiation for personnel in charge of fabricating such lightning conductors is not negligible though it is generally wellknown to the makers. For personnel in charge of installing these radioactive lightning conductors, the irradiation danger is very much smaller. As for the population as a whole, there is danger only in the event of collapse or dismantling by a person unaware of the hazards. Suggestions are made for the control of these devices. (auth)

21180 COLOR DEVELOPMENT OF X-RAY PHOTOGRAPHS AND OTHER PHOTOCHEMICAL METHODS FOR REDUCTION OF RADIATION BURDEN IN CHILDREN. Boeck, G.; Nitz, I.; Tesch, L.; Burgold, R. (Medizinische Univ., Berlin). Paediat. Grenzgeb.; 7: 183-92(1968). (In German).

The use of special x-ray developers and color intensification to increase the resolution of films and thus reduce the radiation burden in children undergoing diagnostic radiography was discussed. X-ray exposure times were decreased by a factor of two when sensitive films and special developers were used. The color intensification effects were obtained by the layering of additional Ag or by transforming the Ag already available into compounds that had increased optical density. Marked changes in the optical density were obtained by this method of chromogenic development. Additives used in the color development process included α-naphthol for blue, and benzoylacetanilide for yellow color effects. (BBB)

21181 RADIATION PROTECTION IN NUCLEAR MEDICAL LABORATORY. Aurand, Karl (Institut fuer Wasser Boden und Lufthygiene, Berlin). Med. Lab.; 19: 296-303(Dec 1966). (In German).

Radiation protection requirements and procedures necessary to comply with international standards and to prevent irradiation injuries were discussed. General radiation protection measures, such as proper construction of buildings and facilities, arrangement of spaces to provide for use of various levels of radioactivity, and provision for adequate sewage disposal and ventilation, were discussed. The use of special types of equipment, including glove boxes, remote dispensing equipment, Pb-shielded chairs, and warning signs was illustrated. Personal radiation protection measures, such as proper handling of radioisotopes; use of special protective clothing, gloves, safety glasses, respirator masks, Pb shields and containers, dosimeters, ionization chambers, film badges, and hand-and-foot monitors; monitoring of urine and feces, and use of whole-body counters to detect internally deposited radioisotopes were discussed briefly. Control of contamination of waste water and prevention of contamination of laboratories and equipment were outlined. (BBB)

21182 DESIGN CONSIDERATIONS FOR LASER EYE PROTECTION. Swope, C. Hermas (Framingham Research Lab., Mass.). Arch. Environ. Health; 20: 184-7(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

The philosophy underlying the design of protective goggles for laser personnel is that the laser light intensity on the retina must not reach the point where photocoagulation occurs. The only two alternatives for accomplishing this are to guarantee that the collimated beam can not be directed into the eye or to supply sufficient attenuation of the beam before it can reach the eye. The attenuation factors that can be achieved in a goggle that still satisfies design specifications for laser personnel in terms of comfort, stability, and resistance to thermal and mechanical shock are presented. The design and performance of reflecting goggles, for use where the angle of incidence on the plate can be limited, and absorbing filter goggles, which are much less difficult to fabricate, are discussed. (E.R.B.)

21183 EYE. Arch. Environ. Health; 20: 197-9(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

A summary of the findings and recommendations of the workshop on the eye, held at the Laser Safety Conference, is presented. It was reaffirmed that the primary hazard from laser radiation is exposure to the eye; radiation levels below those damaging to the eye pose no threat to other body tissues and organs. Data on the energy densities required to produce opthalmoscopically visible threshold lesions on the retina are reviewed, and the paucity of information on the bioeffects of laser radiation in the near infrared region is noted. The commercial availability of protective plastic films, sheet, and plates suitable for fabrication into a variety of configurations was discussed and the criteria for expressing optical exposures were reexamined. The guidelines previously recommended for establishing exposure standards for laser personnel were reaffirmed. It was recommended that investigations be initiated into the effect of chronic exposure to laser radiation, and into the bioeffects of near infrared radiation from lasers, especially in the 800 to 950 nm range and in the uv range from 200 to 350 nm. (E.R.B.)

Safety Procedures

Refer also to abstracts 20966, 21104, 21106, and 21201.

21184 (AEC-tr-7131) METHODOLOGICAL INSTRUCTION ON DIAGNOSTICS AND FIRST AID IN POISONING BY RADIOACTIVE SUBSTANCES. Gus'kova, A. K.; Moiseev, A. A.; Sokolina, L. L. (Ministerstvo Zdravookhraneniya SSSR, Moscow). Translation of a Russian paper. 41p. Dep. CFSTI.

The first section presents information on the basic principles of the metabolism of radioactive substances including: entrance and elimination paths; natural content of isotopes in the human organism; and toxicological characteristics of the most practically important radioactive substances (radioactive isotopes used for γ defectoscopy, isotopes used for controlling and automating technological processes such as thickness or weight, sources used for γ-neutron logging and for control preparations in geological operations, and isotopes used for scientific research). The second section is a discussion of the diagnosis of lesions caused by radioactive substances and the therapeutic measures that can be taken. Dose measurement and evaluation methods are topics included in this section. Tables are used for the presentation of data. (C.O.)

21185 (JAERI-6021) ACTIVITIES IN THE DIVISION OF HEALTH PHYSICS AND SAFETY, APRIL 1, 1968-MARCH 31, 1969. (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 144p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

The activities in fiscal 1968 of the Division are described in the following sections: administration, monitoring and maintenance (organization, operational safety, reactor and laboratory monitoring, personnel monitoring, environmental monitoring, maintenance of monitors and counting instruments, radioactive waste treatment and decontamination); radiation and operational safety techniques (operational safety, control in nuclear facilities, monitoring instruments, bioassay, environmental survey, radioactive waste treatment and decontamination); and research and development (nuclear radiation measurements, internal exposures, environmental radiation and contaminations, radioactive waste treatment and decontamination). Main topics in the research program are as follows: application of microdose concept to the target theory; track recognitions by adaptive linear classifier; development of a lung counter for the detection of ^{239}Pu in vivo; determination of Pu in blood following anion exchange separation; effects of carrier on the retention, excretion and distribution of ^{144}Ce in rats; correlation between ingestion, accumulation, and excretion of fallout ^{90}Sr in man; atmospheric concentration of Mn and Na determined by activation analysis; and meteorological statistics for short period release of gaseous waste. (NSA of Japan)

21186 (SZS-10/69) THE OCCUPATIONAL RADIATION EXPOSURE IN THE GERMAN DEMOCRATIC REPUBLIC IN 1967. Koenig, W.; Larssen, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug 1969. 18p. (In German). Dep. CFSTI (U. S. Sales Only).

Data of the central personnel dosimetry in the G.D.R. are presented for 1967. 23,051 persons were controlled by the Radiation Protection Center with film badges. Altogether, 970 monthly overexposures (more than 0.4 rad) were recorded. In 45 cases the quarterly dose (3 rad) was exceeded during one month, but only 30 of those were real overexposures. The greater part of overexposures is attributable to the insufficient attention to safety regulations. Furthermore, the results were analyzed according to the type of institution, type of employment, as well as to the age of employees. (auth)

21187 (SZS-12/69) THE OCCUPATIONAL RADIATION EXPOSURE IN THE GERMAN DEMOCRATIC REPUBLIC IN 1968. Koenig, W.; Larssen, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug 1969. 18p. (In German). Dep. CFSTI (U. S. Sales Only).

Data of the central personnel dosimetry in the G.D.R. are presented for 1968. 27,165 persons were controlled by the Radiation Protection Center with film badges. Altogether, 1081 monthly overexposures (more than 0.4 rad) were recorded. In 61 cases the quarterly dose (3 rad) was exceeded during one month, but only 46 of those were significant overexposures. The greater part of overexposures is attributable to the insufficient attention to safety regulations. Furthermore, the results were analyzed according to the type of institution, type of employment, as well as to the age of employees. (auth)

21188 PROTECTION OF ASTRONAUTS AGAINST IONIZING RADIATIONS. Whitehill, L. A.; Humphreys, J. W. Jr. J. Amer. Med. Ass.; 211: 1550-1(2 Mar 1970).

The space suits that the astronauts wear apparently afford adequate protection for maintenance of proper levels of temperature, pressure, oxygen, and removal of wastes. Nevertheless, in a hostile environment where protection by the earth's atmosphere is not present there is no guarantee against immediate and delayed effects of cosmic rays, γ rays, x rays, and ultraviolet rays. The formulation of suitable radiation criteria with consideration for risk vs gain and operational and economic feasibility is discussed. (H.L.W.)

21189 RADIOBIOLOGICAL CONCEPTS FOR MANNED SPACE MISSIONS. Pickering, John E. (School of Aerospace Medicine, Brooks Air Force Base, Texas). Aerosp. Med.; 41: 159-65(Feb 1970).

Carefully established premission planning doses and maximum operational dose limits are clearly enhanced by clinical judgments when go-no-go decisions are made in the event of an astronaut's exposure to ionizing radiation. The very nature of extended lunar missions (exploration) and long duration low earth orbit missions are clear cases for evaluating man's clinical response before go-no-go decisions are made. There are well identifiable decision points in mission plans that are best judged by clinical responses if the mission is to avoid performance decrement at critical times, i.e., at the peak of astronaut activity: descent, EVA, ascent, rendezvous, transfer, etc. Careful on-board monitoring of the astronaut's condition and judicious recording and interpretation of actual radiation manifestations with respect to time can and should dissuade premature or unfounded decisions. This philosophy has its greatest merit if one accepts the tenet that man is in the system to make observational judgments and assessments. (auth)

21190 AN OPERATIONAL SAFETY PROGRAM FOR OPHTHALMIC HAZARDS OF MICROWAVE. LaRoche, Laurent P. (Pan American World Airways, Inc., Patrick Air Force Base, Fla.); Zaret, Milton M.; Braun, Albert F. Arch. Environ. Health; 20: 350-5(Mar 1970).

Many instances of known exposure were followed by the development of typical microwave lens changes. Characteristically, these begin as thickening and opacification of the lens capsule at the posterior surface of the lens. Once formed, there is no regression. Although there may be long dormant periods, the changes in the capsule eventually progress until the capsular opacification is extensive. The cases reported demonstrate the latency and slow evolution of microwave cataractogenesis in man. Following irradiation, it is not unusual for the appearance of pathology in the capsule to be delayed for several years. Further, the process can lie dormant for many years before visual acuity begins to fail.

However, acute exposure to high-power densities greater than 500 milliwatts/sq cm can result in the formation of cataracts within weeks. A prolonged course results from exposures to power densities less than 500 milliwatts/sq cm and the accumulation of exposure data indicates that exposures approximating 100 milliwatts/sq cm might have a causal relationship to cataractogenesis. Therefore, it is not, in our opinion, clinically credible to permit access to environments exceeding 10 milliwatts/sq cm, no matter how briefly, and consider it safe. This program points out the need for at least two types of specialist who are not ordinarily found in an occupational medicine program. The first is the engineer who must be skilled in microwave engineering. He must be familiar with computations for the prediction of hazard potential based on operating factors. He must be able to apply the results of computations to real situations in the field. He must be able to go into the field, analyze hazardous situations, and obtain accurate physical measurements. At Pan American, personnel trained and skilled in health physics are assigned to this part of the program; likewise, an ophthalmologist with experience in microwave effects is essential. The orientation of management concerning the hazards involved is of great importance. Safety operating instructions must be disseminated to the employees working with or in the vicinity of systems capable of producing hazardous levels of microwave radiation. (auth)

21191 A PRELIMINARY STUDY OF NATIONAL HEALTH HAZARDS FROM LASERS. LaNier, Marshall; Rose, Vernon E.; Powell, Charles H. (Dept. of Health, Education, and Welfare, Cincinnati). Amer. Ind. Hyg. Ass. J.; 31: 60-8(Jan-Feb 1970).

The techniques of industrial hygiene and epidemiology have now been combined in an effective survey procedure that permits the assessment of potential occupational health hazards associated with laser operations. Included in this assessment are such factors as the physical characteristics of the laser and laser area, the operating procedures and controls, and health services and programs available to the laser operator. Results are based on a statistical sample of the lasers in the United States and are representative of industrial, research, communication, and educational groups who are known to use lasing devices. (auth)

21192 A STUDY ON THE RADIATION LEAKAGE FROM ELECTRON MICROSCOPES. Konishi, Emiko; Ono, Michizane (Tokyo Univ.). Hoken Butsuri; 4: 594-602(Dec 1969). (In Japanese).

In spite of the increasing use of electron microscopes, very few considerations have been given to the emission of radiation from the equipment. This is mainly due to the fact that the radiation is emitted as an unwanted by-product of the equipment. Radiation surveys were carried out on twelve microscopes of Japanese manufacture. Informations obtained from the surveys were: (1) Radiation leakage was observed from eight microscopes. (2) The electron gun, viewing window, and photo-chamber were main locations where radiation leakage was observed. (3) Structural defects in the equipment were important causes of radiation leakage. Following opinions were offered from a health physics standpoint: (1) The equipment is required to be constructed and installed so as to provide adequate protection. (2) A legalistic radiation safety standard is needed for the equipment manufacturer. (3) In a radiation safety program, it is important to obviate any radiation leakage rather than to assess the doses liable to be incurred. (auth) (NSA of Japan)

21193 SECOND INTERNATIONAL LASER SAFETY CONFERENCE AND WORKSHOPS, CINCINNATI, MARCH 24-25, 1969. Arch. Environ. Health; 20: 146-211(Feb 1970). (CONF-690333).

Separate abstracts were prepared for 10 of the 12 papers presented at the conference. The other papers were of a general nature opening the conference, discussing its plans and goals, and discussing developments in laser instrumentation and calibration. Also, a separate abstract was prepared on one of the four workshops, the summaries and recommendations of the workshop on eyes. The reports of the other workshops; on skin, environmental laser contamination, and laser safety training, were in abstract form. (E.R.B.)

For abstracts of individual papers see: 21182, 21183, 21194–21196, 21201, 21306, 21307, 21317, and 21318.

21194 LASERS IN METALWORKING AND ELECTRONIC INDUSTRIES. FOR PROCESSING MATERIALS AND COMPONENTS. Hardway, Glenn A. (Spacerays, Inc., Burlington, Mass.). Arch. Environ. Health; 20: 188-92(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

Three types of laser systems as they apply to a wide variety of materials processing applications for the metalworking and electronic industries are reviewed. These applications include hole drilling, resistor trimming, scribing of silicon wafers, helixing cylindrical resistors, controlled fracturing, welding, and dynamic balancing. The equipment to accomplish these tasks for industry must be fully automatic or semiautomatic and completely compatible with both production operations and advanced manufacturing or research applications. The three basic devices reviewed are the pulsed ruby laser, the continuous and pulsed carbon dioxide (CO_2) gas laser, and the neodymium doped yttrium aluminum garnet (YAG) laser. By properly controlling and applying their output energy in the applications described here, they can join or remove material in a manner offering advantages over the more conventional methods. These lasers are ruggedly designed and extremely reliable devices. They are self-contained, complete units capable of continual high repetition operations at rated outputs over extended periods of time, and require only unskilled personnel to operate. (auth)

21195 PROGRESS IN LASER SAFETY IN BIOMEDICAL INSTALLATIONS. Goldman, Leon (Univ. of Cincinnati Medical Center). Arch. Environ. Health; 20: 193-6(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

Laser safety programs continue to be important in all phases of laser biomedical applications. In view of expansion in laser technology with higher output systems of older lasers and increasing use of continuous-wave systems, especially for laser surgery, many in infrared, increasing uses of new lasers, holography, and atmospheric propagation of laser systems, new programs have to be devised and older guideline figures revised. A plea is made for the establishment of an institute of laser biology and medicine to develop more rapidly and more effectively, programs for laser safety in man. (auth)

21196 RECOMMENDATIONS OF THE SECOND INTERNATIONAL LASER SAFETY CONFERENCE. Powell, Charles H. (Univ. of Missouri, Columbia). Arch. Environ. Health; 20: 207-11(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

The Laser Safety Conference held in Cincinnati, March 24-25, 1969, considered the laser data presently available. Specific recommendations for furthering the protection of the health of both the workers and the general community exposed to laser energy and for controlling the environment of laser operations were made in these areas: eye protection, protection of the skin, control of the environmental contaminants from the use of lasers, and teaching and training of laser safety. Mechanisms for implementation of these recommendations included a discussion of the relationship of various official and professional organizations in the development of laser standards or safety guides; need for university graduate training of individuals for the recognition, evaluation, and control of nonionizing radiation; the need for additional research information; the development of an ecologic center for the study of the health effects from nonionizing energy; a national registry of laser injuries; and a recommendation for a White House conference on laser safety in addition to the continuation of the laser safety conference and workshops. The criteria for the protection of the eye and the skin at specific and discreet wavelengths from the First International Conference on Laser Safety and Workshops were reaffirmed by most of the nation's leaders in laser technology and safety who were in attendance at the second international conference. The need was discussed for development of techniques in cooperation with interested official and professional organizations to assure the implementation of these criteria on a national basis. The development of university graduate school programs for the training of individuals not only in laser safety and technology, but in the general area of environmental health, including protection from all of the nonionizing radiations, were recommended to the laser conference. This is one technique for the implementation and development of the particular expertise and resources required to resolve these environmental problems. A need was noted for additional research before meaningful scientific based laser guides and standards could be developed for all laser energies. There is also a need to resolve the pressing problems of evaluation and control of the nonionizing radiations. The development of an ecologic center or centers to study the effects of nonionizing radiation upon man in his ecosystem was suggested as one primary technique for the implementation of the basic requirements for graduate school training and research in laser safety technology, as well as other areas of nonionizing radiation. The need for and the suggestion of a national registry of laser injuries as a mechanism for evaluation of human exposure to laser energy was reaffirmed. Probably the best technique for the development of this data was suggested at the First International Laser Safety Conference and Workshops. A definitive stand and further

action should be taken by the conference to investigate possible mechanisms for supporting this recommendation. In addition, a recommendation was made for a White House conference on laser safety to focus the nation's attention on the need for the development of a national policy on the control, not only of laser hazards, but of all of the nonionizing radiation. The need was also expressed for the continuation of the Laser Safety Conference and Workshop sponsored by the University of Cincinnati and the Public Health Service. (auth)

Civil Defense

21197 (FMB-69-7) RADIATION PROTECTION OF THE PUBLIC IN A NUCLEAR CATASTROPHE. Pretre, S.; Brunner, H. (Forschungsinstitut fuer Militaerische Bautechnik, Zurich (Switzerland)). May 1969. 101p. (In German). Dep. CFSTI (U. S. Sales Only).

From May 26 through June 1, 1968, a symposium was held in Interlaken, Switzerland in which 230 radiation and civil defense experts from 23 countries participated. Surface explosions of nuclear weapons were assumed to occur either accidentally or intentionally outside the borders of Switzerland. Fallout effects on the Swiss population were discussed. Four main areas were covered: properties of radioactive particles, dispersion of particles by wind, protective measures, and radiosensitivity of man. Some of the conclusions of the conference are as follows: local fallout particles are too large to present an inhalation problem, eliminating the need for gas masks. The major danger is represented by external radiation necessitating stay in fallout shelters for at least two weeks; radioactive strontium poses a smaller internal radiation hazard than previously assumed; radioactive iodine isotopes, on the other hand, are more hazardous than expected, especially to children. Problems of the recovery phase are discussed. (H.B.G.)

Legal Aspects

Refer also to abstracts 21152, 21306, 21315, 21317, 21325, 22362, 22434, and 22435.

21198 (STI/PUB-244) AGREEMENTS REGISTERED WITH THE INTERNATIONAL ATOMIC ENERGY AGENCY. Third Edition (Up to 31 December 1968). Legal Series No. 3. (International Atomic Energy Agency, Vienna (Austria)). 1969. 99p. Dep. IAEA $3.00.

21199 (SZS-9/69) JUDGEMENT OF NUCLEAR AND RADIATION SAFETY OF NUCLEAR PLANTS. Albrecht, L.; Burkhardt, W.; Gegusch, M.; Schimmel, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Sep 1969. 10p. (In German). Dep. CFSTI (U. S. Sales Only).

In the G.D.R. the construction and operation of nuclear plants require a license of the Radiation Protection Center. This license is founded on the judgement of the radiation safety of the whole plant. General principles for the judgement are compiled. According to these principles the Radiation Protection Center checks the submitted technical documentation, gives the necessary directions, and issues the license. (auth)

21200 ADAPTATION OF MEDICAL INSTALLATIONS TO RADIOPROTECTION STANDARDS. Lejeune, S. (Univ. Libre, Brussels). J. Belge Radiol.; 52: VIII-XXII(1969). (In French).

The legal provisions in force in Belgium for the use of radioactive sources are reviewed. How these provisions are applied in large hospitals and the difficulties to which they give rise are discussed. The importance of health physics control in such establishments is emphasized. (C.O.)

21201 PLACE OF FEDERAL LAW IN LASER SAFETY. Moore, Raymond T. (Public Health Service, Rockville, Md.). Arch. Environ. Health; 20: 203-6(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

The activities of the Bureau of Radiological Health of the Public Health Service, since the enactment of the Radiation Control for Health and Safety Act in 1968, are described. These activities include laying the groundwork for development of laser radiation control procedures and development of facilities and programs for engineering and scientific research to evaluate both technological and biological aspects of laser control. The technological aspects include development of facilities to evaluate: laser emissions, instrumentation, protective devices, and industrial safety test procedures, and to make physical measurements, such as laser-beam power measurements, essential to the development of performance standards and criteria for laser safety, codes of practice in the use of lasers, and laser personnel instruction. The proposed biological investigation facilities are to be used for such activities as: documentation of actual or potential laser effects on man, research in the mechanism of laser-induced eye injuries, establishment of thresholds for laser exposure, and provision of an inventory of potential laser hazards. The correlation of the efforts of the Bureau of Radiological Health with the various state agencies in the administration of the laser control laws is cited along with the need for close cooperation among the many individuals, institutions, and industries that either produce, supply, or use lasers. The effectiveness of federal authority, through legislation, to bring about laser safety at a significant level is limited by the degree of cooperation exhibited among the people in all aspects of laser production and application. (E.R.B.)

Medicine

Refer also to abstracts 20743, 20940, and 21195.

21202 (AED-C-12-19) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 12. NUCLEAR SCIENCE LITERATURE OF EASTERN COUNTRIES. NUMBER 19. RADIONUCLIDES IN BIOLOGY AND MEDICINE. Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct 1969. 218p. Dep. CFSTI (U. S. Sales Only). ZAED DM 12.

A total of 1267 literature citations are presented. These are arranged by area of interest in two main sections: biology (380 references) and medicine (887 references). An author index is provided. (C.O.)

21203 (AED-C-12-20) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 12. NUCLEAR SCIENCE LITERATURE OF EASTERN COUNTRIES. NUMBER 20. RADIATION EFFECTS IN BIOLOGY AND MEDICINE. Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct 1969. 279p. Dep. CFSTI (U. S. Sales Only). ZAED DM 12.

Literature citations on radiation effects are arranged by area of interest in the two sections: biology (482 references) and medicine (1228 references). An author index is provided. (C.O.)

Protective Substances

Refer also to abstracts 21295, 21304, and 21326.

21204 ACCELERATION OF LYMPHOID TISSUE REGENERATION IN X-IRRADIATED CBA/W MICE BY INJECTION OF THYMOSIN. Goldstein, Allan L.; Banerjee, Sipra; Schneebeli, G. L.; Dougherty, Thomas F.; White, Abraham (Yeshiva Univ., Bronx, N. Y. Univ. of Utah, Salt Lake City). Contract I-519. Radiat. Res.; 41: 579-93(Mar 1970).

Thymosin, a lymphocytopoietic preparation obtained from calf thymus, was examined for its effect on the rate of regeneration of lymphoid tissue in CBA/W mice exposed to whole-body x irradiation. In CBA/W mice receiving either an acute (400 R) or a lethal (700 R) dose of whole-body x irradiation, thymosin had a potent stimulatory influence on lymphoid tissue regeneration. Administration of thymosin daily, beginning at 1½ hr after irradiation of the animals, significantly accelerated the rate of weight increase and ^{3}H-thymidine or ^{3}H-deoxycytidine incorporation by spleen and pooled brachial, axillary, and inguinal lymph nodes. Animals treated with thymosin daily for 7 days prior to being subjected to x irradiation had, initially, larger lymphoid structures that were less severely involuted by radiation and exhibited an accelerated rate of regeneration subsequent to exposure to x rays. Radioautographic sections of the lymph nodes and spleens of the thymosin-treated groups demonstrated that thymosin was acting primarily upon the more primitive lymphoid elements. Incorporated ^{3}H-thymidine was localized in the immature thymocytes; only rarely did small thymocytes display radioactivity. (auth)

21205 A METABOLIC CONTROL FOR THE ENHANCEMENT OF RADIATION RESPONSE. Biaglow, J. E.; Ferencz, N. Jr.; Friedell, Hymer L. (Case Western Reserve Univ., Cleveland). Contract W-31-109-eng-78. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 405-11(Feb 1970).

The utilization of insulin and glucose during x irradiation showed a significant increase in radiation responses in Ehrlich ascites tumors in mice. It is concluded that the data strongly support the concept that an alteration of cellular respiration by the addition of insulin and glucose led to an increased oxygen tension in cells and therefore enhanced the radiation response. (C.H.)

21206 THE REPOPULATION OF IRRADIATED BONE MARROW BY THE INFUSION OF STORED AUTOLOGOUS MARROW.

Gerdes, Arthur J.; Storb, Rainer (Univ. of Washington, Seattle, USPHS Hospital, Seattle). Radiology; 94: 441-5(Feb 1970).

Midplane doses of 4,000 Rads γ radiation were delivered to eight dogs in four weeks, after when four animals were reinfused with stored autologous marrow while the remaining four served as controls. Peripheral blood counts, marrow aspirations, and serial ^{99m}Tc marrow photoscans did not demonstrate any detectable difference in the two groups. (auth)

21207 THE THYMUS: A HEMATOPOIETIC ORGAN. IV. INTRAVENOUS LYMPHOCYTE TRANSFUSIONS IN MICE WITH A LETHAL BONE MARROW RADIATION DOSE. Schneiberg, K.; Jonecko, A.; Bartnikowa, W.; Szymaniec, St. Folia Haematol. (Leipzig); 91: 349-68(1969). (In German).

Mice lethally irradiated with a single whole-body dose of 800 R x rays were infused intravenously with a number (4×10^5) of living lymphatic cells per animal. Lymphocytes, lymph node cells, and lymphocytes from Ductus lymphaticus of syngenic and xenogeneic donors were injected. Survival-rate was remarkably prolonged in a number of recipients when compared to control mice. This result was interpreted as evidence for the precursor-character of some lymphatic cells, and for their position as stem cells for the myeloid, especially granulocytic, series. Xenogeneic cells were shown to be, paradoxically, more effective than the mouse's own cells. However, after having survived the acute phase of radiation damage, the chimerized animals died of secondary disease. Thymectomized mice died more quickly after a dose of 800 Rads than did control mice, this difference being changed by means of grafting lymphatic cells. A generalizing hypothesis is put forward: a lymphatic cell will not reveal its precursor-character unless functionally stimulated. Antigenic incompatibility is thought to furnish an adequate functional stimulation in a xenogeneic rat-mouse transfusion-system. (auth)

21208 A THREE-DIMENSIONAL MATRIX FOR THE STUDY OF MICROBIAL RADIATION AND SURVIVAL IN THE DRY STATE. Baker, Fredrick D.; Hotchin, John (New York State Dept. of Health, Albany). Cryobiology; 6: 116-20(Sep-Oct 1969).

A technique is described for preparing a 3-dimensional semi-solid rigid matrix for studying the uv-induced inactivation of biological material suspended in a nonaggregated dry state. Various substances were compared for preparing supportive matrices and tested for recovery of T_1 phage before and after uv radiation. One % methylcellulose was selected as the matrix since good survival of the T_1 phage lysate was present prior to radiation, and this matrix was highly uv transparent. The protective effect of additives against uv inactivation was studied, and a combination of lactose, glutamate, N-Z-amine, and carbon black was shown to protect completely against inactivation and also to protect against nonspecific inactivation unconnected with the radiation. (auth)

21209 EXPERIMENTAL STUDY OF THE SKIN REACTION ON COMBINED ACTION OF X-RAYS AND PREDNISOLONE. Karnaukhova, E. K. (Inst. of Experimental and Clinical Oncology, Moscow). Byull. Eksp. Biol. Med.; 68: No. 11, 103-4 (Nov 1969). (In Russian).

After local fractionated x irradiation of the skin of mice, administration of prednisolone increased the harmful effects of x irradiation on the growing hair follicles by 1.5 to 1.7 times. (auth)

21210 EFFECT OF 5-HYDROXYTRYPTOPHAN ON RADIOSENSITIVITY OF CELLS IN VITRO. Toyoshi, Kazumi (Gifu Coll. of Pharmacy, Japan); Nakamura, Wataru. Yakugaku Zasshi; 89: 1469-73(Oct 1969). (In Japanese).

The possible protective effect of 5-hydroxytryptophan against radiation damage was examined in vitro, using the ascites tumor type Furth's mastcytoma cells which have the ability to synthesize 5-hydroxytryptamine and Ehrlich ascites tumor cells not having such ability. Protective effect was judged by the amount of 5-hydroxyindole excreted in 24-hour urine of the host mice, $(C57L \times A)F_1$ female, in the case of Furth mastcytoma cells, and the body weight increase rate in ddN male mice in the case of Ehrlich ascites cells after transplantation of the cultured cells. Observations were made 8 to 10 days after transplantation of the cells. X irradiation of the cells was made in a dose of 1000 R, and the number of cells transplanted was 4×10^6 cells/0.5 ml in the case of Furth cells and 20×10^6 cells/0.5 ml in the case of Ehrlich cells. Protective effect of 5-hydroxytryptophan was seen in the case of Furth cells in a dose of 1 mole/25,000 cells, but not in the case of Ehrlich ascites tumor cells. (NSA of Japan)

21211 PREVENTIVE AND CURATIVE EFFECTS OF CET-1 AGAINST LEUCOPENIA IN CASE OF CANCER TREATMENT. Awazu, Saburo; Tsuchiya, Toshibumi (Toho Univ., Tokyo). Shinyaku To Rinsho; 18: 1045-9(Aug 1969). (In Japanese).

Cytochrome C, as enteric-coated granules (CET-1), was administered in 10 mg doses three times/day for four weeks to cancer patients during the course of x radiotherapy. The protective effect of CET-1 against the development of leukopenia was studied. Counts were made of the number of erythrocytes and leukocytes in samples of peripheral blood. No change was observed in the number of erythrocytes. The severity of leukopenia following the administration of CET-1 was greatly reduced as compared with controls. Administration of CET-1 to patients following the development of leukopenia was less effective than when it was administered as a prophylactic. (NSA of Japan) (C.H.)

21212 RADIOPROTECTION EXPERIMENTS WITH NUCLEIC ACIDS. Marinescu, C.; Popa, Monica; Cavulea, O. Rev. Sanit. Mil.; 72: 61-4(Jan-Feb 1969). (In Rumanian).

Homologous nucleic acids prepared from the intestines of mice were tested in the treatment of radiation sickness. Radiation sickness was induced in the Wistar species of mice used for the experiments by exposure to 700 R of x radiation. Administration of the extract resulted in an increase of the survival rate of the exposed animals; this became significant only after 20 and 30 days following the irradiation, although the nucleic acids were administered from the second day on. The results also indicated that the nucleic acids from the intestines have a similar therapeutic effect as those obtained from other organs. The substitution mechanism of damaged nucleic acids is probably related to exogenic acids; the normal nucleic acid synthesis is reestablished after exposure through the fragments from the metabolized nucleic acids administered to the animals. (TTT)

21213 EFFECTS OF ACTINOMYCIN ON LIVERS IN MICE PREVIOUSLY IRRADIATED. Schwarzlose, W.; Saebel, M. (Univ., Erlangen, Ger.). Strahlentherapie; 139: 96-9(Jan 1970). (In German).

Two and a half months after x-irradiation (1000 Rad) of livers of five day old white mice, the following items still were in a decreased state in relation to the controls; body weight, weight of liver, number of cells, DNA, RNA, and protein content of liver. Two weeks treatment of two months old animals with doses of 20 μg kg actinomycin C neither provoked a significant alteration in body weight, weight of liver, and total of cells, nor in DNA, RNA, and protein content of liver. Body and liver weights as well as DNA/RNA liver content in animals that had undergone two weeks of actinomycin treatment two months after irradiation had significantly decreased in relation to animals that had been subject to mere irradiation ($P < 0.05$). Differences with regard to protein content and total of cell nuclei of liver were not significant. Damages caused by irradiation are presumed to intensify by actinomycin aggregation at the DNA of the cell nucleus. (auth)

21214 EXPERIMENTAL STUDIES CONCERNING THE RADIOPROTECTIVE ACTION OF CYSTEINE AND CYSTEAMINE. Heitmann, Hans-Joachim; Sturde, Hans-Carl (Univ., Bochum, Ger.). Strahlentherapie; 139: 91-5(Jan 1970). (In German).

The protective effects of cysteine and cysteamine were studied on the isolated intestine of guinea pigs. The intestine was placed in an aqueous solution of histamine and irradiated with doses of 50 to 8000 R. In this way modifications and loss of pharmacological effects were easily detected. Adding cysteine and cysteamine modified the inactivation induced by the irradiation. After doses of 2000 to 8000 R, 6 to 24 μ/ml of cysteine or cysteamine should be added, in order to protect an aqueous solution of histamine for the irradiation effect. (auth)

21215 EFFECT OF SEROTONIN ON THE THYROID ACTIVITY OF THE INDIAN DESERT GERBIL, MERIONES HURRIANAE. Srivastava, Pratap N.; Devi, P. Uma; Swarup, K. (Univ. of Rajasthan, Jaipur, India). Strahlentherapie; 139: 84-6(Jan 1970).

The Indian desert Gerbil, Meriones hurrianae, were treated with serotonin and AET. Serotonin reduced the protein-bound iodine conversion ratio and thus brought about hypothyroidism reducing the basal metabolic rate. The effectiveness was the same irrespective of the fact whether serotonin was given 4 hr before or 2 hr after irradiation. (auth)

21216 THE ACTION OF A RADIOPROTECTOR (AET) ON THE DISTRIBUTION OF H-3-THYMIDINE IN BONE MARROW CHROMOSOMES OF THE RAT. AET-ACTION ON THE UPTAKE OF LABELLED THYMIDINE BY CHROMOSOMES. Brasch, J. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Acta Biochim. Biophys. (Budapest); 4: 333-5(1969).

The uptake of ^3H-thymidine by chromosomes was studied in bone marrow cells of S-2 aminoethylisothiourea dihydrobromide (AET)-treated rats. This radioprotector decreased ^3H-thymidine uptake to the same extent as did γ rays; however, without affecting the heterochromatic regions of the chromosomes. A further decrease of DNA synthesis occurred in the AET-treated + irradiated animals. The causes of these differences are being examined. (auth)

21217 USE OF GERANYLHYDROQUINONE AS RADIATION PROTECTIVE AGENT. Baranger, Pierre. U. S. Patent 3,424,848. Jan. 28, 1969. Priority date July 20, 1962, France.

A method is described for alleviating in mammals at least one of the nausea, asthenia, epithelial, and actinic reactions and the adverse effects on the red and white corpuscles associated with exposure to x rays of γ rays that comprise administering to the mammal an effective, essentially non-toxic amount of geranylhydroquinone. (Offic. Gaz.)

21218 FRACTIONATION OF SPLEEN AND SERUM IN ATTEMPTS TO ISOLATE THE RADIATION-LEUKEMIA PROTECTION FACTOR. Clewell, Don B.; Hubbard, J. Donald; Yu, Pao-lo; Yip, Lily C.; Hodes, M. E. (Indiana Univ., Indianapolis). Cancer Res.; 29: 1333-40(Jul 1969).

The leukemia induced in C57BL mice by x irradiation can be prevented by injection of extracts of sheep spleen or serum. These materials were fractionated by ammonium sulfate precipitation followed by chromatography on Sephadex G-200. Radiation-leukemia protection (RLP) activity precipitates partially between 0 to 40% and 40 to 60% saturation with ammonium sulfate. During chromatography on Sephadex, most of the leukemia protective activity appears to elute with the higher molecular weight proteins of sheep spleen but with the smaller proteins of sheep serum. All the preparations tested were heterogeneous on polyacrylamide gel electropherograms. It is suggested that more than one polypeptide exhibits leukemia protection activity. Results are reported from studies on the effectiveness of injected extracts for the protection of mice against lymphosarcoma. (C.H.)

Radiation Sickness and Injuries

Refer also to abstracts 20989, 21169, and 21184.

21219 RECOGNITION AND TREATMENT OF RADIATION INJURIES OF THE SKIN. Beisenherz, D. (Univ., Duesseldorf, Ger.). Arbeitsmed.-Sozialmed.-Arbeitshyg.; 4: 15-19(Jan 1969). (In German).

Acute and chronic x-ray injuries were investigated. The time between exposure and lesion appearance varied between a few days and more than 30 yr. Early erythema, with a bulla arising soon afterward, and an erosive reaction always indicated severe x-ray damage. Chronic x-ray damage was recognized by epidermal scaling and hyperkeratosis, pigmentation of the injured skin, irreversible enlargement of the papillary bodies, increase and angiomatous enlargement of the capillaries of the injured skin region, at the finger- and toe-nails by oblong grooves, dyskeratosis, and sometimes chronic paronychia of the nail-folds. Erythema reactions caused by x rays were treated best with powder bandages, bullae by incision, and erosive reactions with wet bandages using dye solutions after epithelization with a protective ointment. Protective ointments were used only after the x-ray treatment was finished. Since x-ray-damaged skin was potentially precancerous, irradiation treatment of damaged skin or basaliomas and carcinomas was avoided. Additional injury by uv irradiation was prevented in damaged skin. The recommended treatment of x-irradiated skin was operative excision followed by a skin graft. (BBB)

21220 HOT SPRING THERAPY FOR RADIATION INJURY. 25. RESULTS FROM THE BEPPU HOT SPRING UTILIZING LABORATORY FOR A-BOMB SUFFERERS. 10. Hatta, Osamu. Oita-ken Onsen Chosa Kenkyu-kai Hokoku; No. 20, 83-5(Mar 1969). (In Japanese).

Effects of hot spring therapy for radiation injury were investigated for a year from April 1968 to March 1969. The number of users in this year was 1690 which was 215 more than last year. The statistics were taken on items such as users' sex, the number of users during each month, and the degree of radiation injuries, and were compared with the last period. Many cases of white blood corpuscle abnormality and high blood pressure were observed. The result of therapy in this period was almost the same as the last period, and the effects were noticed especially on white blood corpuscle abnormality and the decrease of red blood cells. Further detailed investigation showed that such abnormality appeared after hot spring therapy but was not observed before the therapy. The degree of improvement of symptoms before and after therapy, which was represented by the number, that is, the total fault number after the therapy was subtracted from those before the therapy and the difference was divided by the number of total subjects, was 0.4848 this year, and far higher than 0.2807 of the last period. The results showed the significance of bathing. (NSA of Japan)

21221 SHOULD TEETH BE REMOVED PRIOR TO RADIATION THERAPY. Gehrig, John D. (Univ. of Washington School of Dentistry, Seattle). Dent. Clin. N. Amer.; 13: 929-38(Oct 1969).

Oral radiation effects are reviewed in relation to osteoradionecrosis, and its incidence, prevention, and treatment in oral radiotherapy are reviewed. Radiation, irrespective of source, causes fibrous thickening and obliterative endarteritis in the affected tissues. Bone is particularly susceptible to radiation change. There is eventually a definite reduction in blood supply to the bone and overlying soft tissue. Once the bone is exposed and osteoradionecrosis is present, treatment is primarily palliative. Definitive treatment, except for wide resections up to vital nonirradiated bone, is usually unsuccessful. Another consequence of irradiation of the oral cavity is radiation caries. The loss of salivary secretions probably contributes significantly to radiation caries, seen as a peculiar V-shaped erosive decay that notches the cervical line of healthy teeth and causes eventual fracture and loss of the crown. This usually occurs within 18 months following treatment. The arguments for and against removal of teeth in the region to be irradiated are considered. (BBB)

Radiodiagnosis

Refer also to abstracts 21036, 21065, 21158, 21172, 21173, 21175, 21180, and 21313.

21222 (LIB/Trans-237) ^{99m}Tc-IRON (II) COMPLEX: A NEW SUBSTANCE FOR BRAIN TUMOURS SCINTIGRAPHY. Schmidt, K. J.; Haas, J. P.; Brod, K. H.; Wolf, R.; Dietz, H. Translated by U. Engelbert (AAEC, Research Establishment, Lucas Heights), from Atompraxis; 14: No. 4/5, 5-68(1968). Dep. CFSTI (U. S. Sales Only).

The application of ^{99}Tc-labeled iron (II) complex for the brain tumour scintigraphy was found to be superior to ^{99}Tc-labeled pertechnetate. The advantages of the complex lie in the relatively rapid decrease of the activity concentration in the blood because of excretion via the kidneys and in the enrichment of activity in the tumour. The radiation dose to the patient is also relatively low. The critical organ is the kidney, which is exposed to between 10 to 20 rads, when 20 mCi of ^{99}Tc-labeled iron (II) complex is applied. (Australia)

21223 ANGIOGRAPHY OF LIVER ABSCESS IN GRANULOMATOUS DISEASE OF CHILDHOOD. A CASE REPORT. Nebesar, Robert A.; Tefft, Melvin; Colodny, Arnold H. (Harvard Medical School, Boston. Children's Hospital Medical Center, Boston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 628-31(Mar 1970).

Angiography using ^{99}Tc-labeled sulfur colloid for scanning in a case of chronic granulomatous disease of childhood showed hepatic enlargement and extensive hypervascularity with prominent and displaced hepatic arteries and enlarged small hepatic branches. It is pointed out that were it not for the characteristic clinical history, the angiogram could be confused with malignant tumor within the liver. The differences and similarities between this case and other reported inflammatory lesions are discussed. (C.H.)

21224 LIVER SCANNING IN PATIENTS WITH SUSPECTED OR PROVEN CANCER. Lin, Shu-ren; Mansfield, Carl M.; Kramer, Simon; Southard, Martha E. (Jefferson Medical Coll., Philadelphia). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 98-101(Jan 1970).

A survey on 1,151 patients with proven cancer referred for liver scanning showed that 39% had evidence of metastatic disease. Of those referred for scanning as part of their initial work-up for suspected cancer, 33% had abnormal scans. Rose bengal labeled with ^{131}I was used for scanning. The magnitude of these two percentages indicates that liver scanning is of great value in the routine work-up of the patient with proven or suspected cancer. (C.H.)

21225 STACK SCANNING: SIMULTANEOUS MULTI-FILM PHOTO-RECORDING OF ISOTOPE SCANS. Dockray, K. T.; Apgood, E. R.; Beaty, W. R.; Garrison, J. E.; Cassady, C. K.; Elliott, R. E. (Univ. of Arkansas, Little Rock). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 416-23(Feb 1970).

Stack scanning is a multi-film method for expanded information recording and display of nuclide concentrations. In this technique, maximized light emissions from a scanner penetrate, not one, but several films layered in the photo-cassette. Low and high counting rates are simultaneously recorded by the same transit of the detector over the patient. Thinned target margins are mapped, internal count rate defects are enhanced, and technical errors in making the scans are prevented. With a typical three film stack scan, it was proved that the most heavily exposed film sheet (S-1) shows nuclide arrays with counting rates extending down to a few 100 per minute; that the second film sheet (S-2) equals conventionally set single film scans; and that the third film (S-3) often

simulates scans made with 70 to 80% of the lower counting rates raised. Stack films need no complicated processing after normal development. They stand as permanent, life-size records, and they provide the only simple recording mode for standard equipment that does not suppress, cut out, or otherwide degrade useful data. (C.H.)

21226 OBSERVATIONS ON THE USE OF ^{99m}Tc ALBUMIN MACROAGGREGATES FOR DETECTION OF THROMBOPHLEBITIS. Rosenthall, Leonard; Greyson, N. David (Montreal General Hospital). Radiology; 94: 413-16(Feb 1970).

Scanning of the lower extremities with ^{99m}Tc macroaggregates of human serum albumin was performed in 40 patients. Complete venous obstruction, entrapment by mural thrombi with endothelial damage, and venous stasis produced similar images. This procedure appears to be of only limited value in anticoagulant therapy, but may be useful when employed serially in the same patient. (auth)

21227 CEREBROSPINAL FLUID SCANNING AND VENTRICULAR SHUNTS. Matin, Philip; Goodwin, David A.; DeNardo, Gerald L. (Veterans Administration Hospital, Palo Alto, Calif. Stanford Univ., Palo Alto, Calif.). Radiology; 94: 435-8(Feb 1970).

The routine lumbar injection of ^{131}I human serum albumin (RISA) may be used instead of the more difficult and potentially dangerous intraventricular, cisternal, or direct shunt injections to determine the patency of ventricular shunts in patients with communicating hydrocephalus. In a hydrocephalic with a functioning shunt the path of least resistance is through the shunt via the ventricle with activity localizing in the ventricle within six hours. A false diagnosis of patent shunt could result if there were a complete subarachnoid block above the tentorium. (auth)

21228 ELIMINATION OF COLLIMATOR ARTIFACTS IN SCINTILLATION-CAMERA IMAGES. Bramlet, Roland C. (Long Island Jewish Hospital, Jamaica, N. Y.). Radiology; 94: 417-19(Feb 1970).

An experimental arrangement which permitted the parallel multihole collimator of a γ camera to be set in rotary motion during image formation was fabricated. Various test sources of ^{99m}Tc were imaged with the collimator. With the collimator stationary an image of holes and septa of the collimator was projected into the picture of test sources as imaged by the camera. With the collimator in motion the image of the collimator was eliminated from pictures of test sources. Possible practical use of a moving collimator to eliminate collimator artifacts from γ-camera images is considered. (auth)

21229 EVALUATION OF REGIONAL PERFUSION AND VENTILATION USING ^{133}Xe AND THE SCINTILLATION CAMERA. Mishkin, Fred S.; Brashear, Richard E.; Reese, Isaac C. (Indiana Univ., Indianapolis). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 60-70(Jan 1970).

Experimental models of a pulmonary embolus, bronchial obstruction, and embolus combined with bronchial obstruction were made in anesthetized dogs. Rapid serial images obtained with a scintillation camera allow visual estimation of regional perfusion and ventilation by recording the distribution of intravenously injected ^{133}Xe during suspended respiration and washout. Pulmonary embolism was not accompanied by significant regional air trapping. Bronchial occlusion showed an accompanying perfusion abnormality, and marked ^{133}Xe trapping. Pulmonary artery occlusion with bronchial obstruction showed absence of ^{133}Xe activity and no entry of ^{133}Xe into the lung via systemic circulation. Brief case reports on human patients show how these data can be usefully applied to clinical problems of hypoxemia in guiding diagnostic and therapeutic decisions. (auth)

21230 IODINE LABELS HELP TO DETECT CLOTS IN VEINS. J. Amer. Med. Ass.; 211: 2083-4(30 Mar 1970).

The use of fibrinogen labeled with ^{125}I for scanning gave good results in detecting postoperative deep venous thrombosis in a group of 20 selected patients. Lugol's iodine or sodium iodide was given preoperatively and daily for the first postoperative week to prevent ^{125}I uptake by the thyroid gland. Fibrinogen labeled with ^{125}I was injected one day before surgery. Counts were made with a shielded probe along the course of the femoral vein from one to seven days postoperatively. All patients with elevated counts in one location for two consecutive days developed deep venous thrombosis at that site, which was confirmed by phlebography. (C.H.)

21231 EVALUATION OF CHEST MASSES IN CHILDREN WITH EARLY AND DELAYED RADIONUCLIDE ANGIOGRAPHY. Conway, James J.; Sherman, Joseph O. (Northwestern Univ., Chicago). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 575-81(Mar 1970).

The vascular dynamics of chest masses in children were studied by radionuclide angiography. This technique utilizing a single intravenous injection of ^{99}Tc eliminates the necessity for catheterization. This simple and rapid procedure provides new information, thereby enabling a more accurate preoperative differentiation of the large variety of chest masses which may be present in infants and children. (auth)

21232 CONSTRUCTION OF A FUNCTIONAL IMAGE FROM SPATIALLY LOCALIZED RATE CONSTANTS OBTAINED FROM SERIAL CAMERA AND RECTILINEAR SCANNER DATA. Kaihara, Shigekoto; Natarajan, T. K.; Maynard, C. Douglas; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore, Bowman-Gray Medical School, Winston-Salem, N. C.). Radiology; 93: 1345-8(Dec 1969).

A method of constructing a functional image from localized rate constants calculated from digitalized data of scintillation image is described. This method was tested in three models and found to be useful in assessing the regional function of certain organs when that function was related to the rate of change of localized radioactivity. (auth)

21233 SCINTIGRAPHIC AND ANGIOGRAPHIC DIAGNOSIS OF KIDNEY TUMORS. Hennig, K.; Franke, W.-G.; Woller, P.; Platzbecker, H.; Kirsch, E. (Carl Gustav Carus Medizinische Akademie, Dresden). Deut. Gesundheitsw.; 24: 2227-33(20 Nov 1969). (In German).

Results are reported for 52 patients with kidney tumors subjected to scintigraphic and angiographic examinations which were reliably diagnosed in respect to histological findings. The findings are demonstrated by examples. It was concluded that technical simple renal radioisotope scanning, which can easily be carried through at any time, is much more valuable for the detection and differentiation of expansive pathological processes than has been assumed up to now. The application of scintigraphic and angiographic methods in the diagnostic program has to be adapted to the respective diagnostic questions, the specific tumor properties, and the patient's state of health. (auth)

21234 IHSA–BBD COMPLEX AFFINITY FOR MALIGNANT NEOPLASMS: A NEW POTENTIALLY DIAGNOSTIC AND THERAPEUTIC RADIOPHARMACEUTICAL. Penn, H. S.; Kakehi, H.; Arimizu, N.; Akiba, H. (Univ. of Chiba, Japan). Radioisotopes (Tokyo); 19: 14-20(Jan 1970).

Animal experiments showed that a bovine bile derivative (BBD) (90–95% taurocholic acid) combined with rat globulin localized preferentially in thyroid, stomach, and in transplanted Walker-256 carcinosarcoma. The clinical applicability of ^{131}I-HSA complex with BBD was evaluated. The BBD-^{131}I-HSA complex, ranging from 130 μCi to 1 mCi, was used for scanning 21 inoperable, histologically verified cancer bearing patients for evaluation of the diagnostic potential. Fifteen cases out of twenty-one were positive, showing increased activity over tumor areas on the scintigram. The scintigram revealed the radioisotopes concentrated not only in tumor but in the thyroid, cardiac area, liver, and stomach as well. Seven positive cases, six of which were considered terminal, were selected for therapeutic uses of the BBD-^{131}I-HSA complex. Clinical results are too early to be evaluated, but two cases have distinctly shown clinical improvement. The results of preliminary therapeutic trials, though inconclusive, indicate a promising approach to cancer therapy. (auth)

21235 THE PRESENT SITUATION AND PROBLEM OF NUCLEAR MEDICINE. ITS PROGRESS AND FUTURE PROBLEM. Kakei, Hirotake (Chiba Univ., Japan). Genshiryoku Kogyo; 15: No. 11, 5-8(Nov 1969). (In Japanese).

Progress in the field of nuclear medicine in Japan is summarized. In 1968 the number of institutions using radioisotopes for diagnostic and therapeutic purposes was 289. The number of cases per institution averaged 580, which is twice the amount than in 1965. The most important radionuclides used were ^{131}I, ^{198}Au, ^{99m}Tc, ^{113m}In, and ^{133}Xe. Administrative and financial problems for acquisition and use of the necessary equipment are discussed. Future coordination of government agencies for solving these problems is suggested. (TSS) (NSA of Japan)

21236 VISUAL ASSESSMENT OF REGIONAL MYOCARDIAL PERFUSION UTILIZING RADIOACTIVE XENON AND SCINTILLATION PHOTOGRAPHY. Cannon, P. J.; Haft, J. I.; Johnson, P. M. (Coll. of Physicians and Surgeons, New York). Circulation; 40: 277-88(Sep 1969).

A method was devised to visualize the areas of left ventricle supplied by various coronary arterial branches utilizing scintillation photography and ^{133}Xe gas which distributes instantaneously between coronary blood and perfused myocardial cells. From 1 to 5 mCi of ^{133}Xe dissolved in saline solution was injected through a catheter into the anterior descending or posterior circumflex

branch of the left coronary artery of 15 dogs. Scintillation images produced during arrival and washout of ^{133}Xe in the various regions of the heart were recorded by an image intensifier scintillation camera and high speed television monitor and were reproduced on film during replay of the videotape on an oscilloscope. The resulting scintiphotographs defined the region of the left ventricle supplied by the coronary arterial branch. In 9 of the dogs acute myocardial infarctions were produced by occluding one or the other branch of the left coronary artery. When ^{133}Xe was injected again into the coronary artery proximal to the occlusion, that area of the left ventricle that was deprived of nutrient blood flow was no longer visualized on the γ-ray scintiphotograph. The results indicated that regional myocardial perfusion could be dynamically visualized in the intact animal. (BBB)

21237 APPLICATION OF RADIOACTIVE XENON (^{133}Xe) FOR THE INVESTIGATION OF THE INFLUENCE OF GLUCOSE AND INSULIN UPON THE REST BLOOD FLOW IN MUSCLE TISSUES. PART I. THE TISSUE CLEARANCE METHOD WITH THE APPLICATION OF RADIOACTIVE XENON (^{133}Xe). Graban, Wieslaw. Pol. Przegl. Radiol. Med. Nukl.; 33: 691-7(Sep-Oct 1969). (In Polish).

Radioisotope techniques for measurements of blood flow in muscle tissue are discussed. Historic review of these techniques is given. The physical and mathematical basis for blood flow rate estimations in muscles is presented, and application in the ^{133}Xe technique is described. Selected problems of muscle blood flow physiology and some aspects concerned with the influence of insulin and glucose upon the flow rate are discussed. (auth)

21238 ISOTOPE QUANTITATION OF AORTIC INSUFFICIENCY COMPARED TO CINEANGIOGRAPHY IN MAN. Hildner, Frank J.; Pierson, William R.; Barold, S. Serge; Linhart, Joseph W.; Samet, Philip (Mt. Sinai Hospital of Greater Miami, Miami Beach, Fla.). Ann. Thorac. Surg.; 8: 84-93(Jul 1969).

A new method for quantitating aortic insufficiency (AI) through the use of ^{99m}Tc was discussed. The technique was as simple to perform as aortic angiography, but it distinguished very small amounts of aortic regurgitant flow. This ^{99m}Tc method also provided a graphic representation of stroke volume (SV) and that fraction of SV which left the left ventricle (LV) and subsequently reentered it from the aorta. Amount of AI was expressed as a % of SV. The measurement of AI by aortic angiography (angio AI) and ^{99m}Tc dilution (isotope AI) methods were compared. Aortic valve regurgitation was measured by ^{99m}Tc dilution and contrast aortography in 30 patients with aortic valve disease only. The ranges of regurgitant flow described by the 4 grades of angio AI were considerably different from one another. Although the 1+, 2+, and 3+ grades of AI could be distinguished, the 3+ and 4+ grades overlapped widely and were largely indistinguishable. A limited correlation between degree of AI and aortic diastolic pressure was shown better by ^{99m}Tc AI than by angio AI. No difference between these methods was shown when they were compared to left ventricular end-diastolic pressure or cardiac index. Technically, the ^{99m}Tc dilution method was better tolerated than the angio method, had fewer side effects, avoided the possibility of allergic reaction, and did not alter the steady state. When employed with foreknowledge of its usefulness and limitations, the ^{99m}Tc method for quantitation of aortic valvular insufficiency was an excellent alternative method to angiography. In combination with angiography, it not only provides supplementary information, but also confirmed angiographic results that may otherwise have been unsatisfactory. (BBB)

21239 MEDIASTINAL LYMPH NODE SCINTIGRAPHY IN ANIMALS DURING INDIRECT ISOTOPE LYMPHOGRAPHY OF THE LUNGS. Langhammer, H.; Hertel, E.; Hoer, G.; Pabst, H. W. (Univ., Munich). Fortschr. Geb. Roentgenstr. Nuklearmed.; 111: 798-804(Dec 1969). (In German).

Using the present technique of intra-pulmonary or sub-mucous injection of ^{198}Au into the right lower lobe, most of the colloidal gold remains at the point of injection. Exact estimation of radioactivity in the mediastinum is therefore not possible. By means of animal experiments a method of indirect isotope lymphography of the lungs was developed, which permits satisfactory scanning of the hilar and mediastinal lymph nodes. In order to get an accumulation of colloidal radio-gold in the mediastinal lymphatic system, it is necessary to inject it intrapleurally. The results were confirmed by in-vitro measurements and selective increase in radio-activity of the mediastinal lymph nodes was demonstrated. Differences in the results of intra-pulmonary and intrapleural injections are discussed and the possibilities of clinical applications of this method are indicated. (F. St.)

21240 NUCLEAR MEDICINE IN RENAL DIAGNOSIS. Schneider, G. Radiol. Diagn.; 10: 271-2(1969). (In German).

The role of the radioactive renogram for the screening of kidney patients is discussed. In stenosis of the renal artery atypical renograms appear in 80% of the patients; however, the changes are uncharacteristic. Therefore, other diagnostic procedures must be used in addition to the radioactive renogram. In pylonephritis, the radioisotope renogram shows no typical alteration, but is valuable to assess the functional status of each of the kidneys. After kidney transplantation, the radioisotope renogram serves as an effective tool for early recognition of rejection processes and other complications. (H.B.G.)

21241 ACUTE PSOAS BURSITIS AND UNUSUAL JOINT CYSTS IN RHEUMATOID ARTHRITIS. Jeremy, Ross (Sydney Hospital). Med. J. Aust. 2: 1106-7(29 Nov 1969).

A male aged 50 years presented with acute psoas bursitis due to previously unrecognized rheumatoid arthritis. A fluorine-18 bone scan was helpful in establishing the presence of active arthritis of the hip. The radiological appearance of the hands resembled gout, but there was no supporting evidence for the presence of this disease. (Australia)

21242 COMPARATIVE LIVER SCANNING: TECHNETIUM SULFIDE (^{99m}Tc) VS GOLD (^{198}Au). Cantor, Robert E.; Cohn, Edwin M.; Park, Chung H.; Shapiro, Bernard (Albert Einstein Medical Center, Philadelphia). J. Amer. Med. Ass.; 211: 1677-80(9 Mar 1970).

In 48 patients with suspected liver metastases, liver scans were performed with both technetium sulfide Tc 99m, and gold Au 198. In 90% of the patients, (43 of 48) the interpretations of the sulfur colloid and gold scans were similar. In 10%, (five of 48) the technetium sulfide Tc 99m scans were abnormal, while the corresponding gold Au 198 scans were normal. In all five cases, there was either histologic or strong clinical and laboratory evidence of liver disease. Thus, approximately 10% more intrahepatic lesions were demonstrated with technetium sulfide Tc 99m than with gold Au 198. Spleen scans were easily obtainable in 77% (37) of patients given technetium sulfide Tc 99m. In scanning for metastases, a nonpalpable liver had only a 23% chance (three of 13) of being abnormal, while a palpable liver had a 60% chance (18 of 30) of being abnormal. (auth)

21243 HEPATIC GAMMASCANNING. Ariel, Irving M.; Molander, David; Galey, Donna (New York Medical Coll., N. Y.). Amer. J. Surg.; 11: 5-14(19 Jul 1969).

The advantages of hepatic photoscanning with ^{131}I-Rose Bengal, ^{198}Au, and ^{99m}Tc-sulfur colloid were reviewed and indicated by studies in over 500 patients. The multiple purposes of photoscanning included detection of space-occupying defects in the liver which could represent metastases in patients with cancer within the abdominal cavity who were candidates for surgery; diagnosis of inflammatory lesions in the upper quadrant of the abdomen as well as other focal space-occupying masses that displaced the liver; aid in the differential diagnosis of the location of abdominal masses, either intra- or extrahepatic; aid in determining the extent of hepatic cancer; outline the portal circulation for aspiration needle biopsy, for outlining irradiation fields, and for the percutaneous introduction of radioisotopes into the liver; determined whether a patient with metastatic cancer of the liver is a candidate for cancer chemotherapy; provide serial follow-up studies of a patient with inoperable cancer of the liver to determine treatment policies, such as radiation therapy and cancer chemotherapy; study of blood flow to liver tumors to determine if the intra-aortic arterial administration of certain radioisotopes and anticancer chemotherapeutic agents is indicated in the treatment of hepatic cancer; study of liver regeneration after the surgical extirpation of large segments for cancer; determination of the presence of ascites, other localized collections of fluid, and abdominal masses such as subphrenic abscesses which may displace the liver; and aid in determining hepatic function. The advantages and limitation of ^{131}I and ^{198}Au were discussed. (BBB)

21244 FIVE YEARS OF EXPERIENCE WITH ^{99m}TECHNETIUM SULFUR COLLOID. Hauser, Wolfgang; Atkins, Harold L.; Richards, Powell (Brookhaven National Lab., Upton, N. Y.). N. Y. State J. Med.; 70: 848-54(1 Apr 1970).

Experience over a five-year period led to the conclusion that ^{99m}Tc-S colloid is the scanning agent of choice for liver, spleen, bone marrow, and lymph nodes. The production of the colloid is not time consuming, and its use is safe. A scanning method is described that best complements the use of technetium-99m. With this method it was possible to extend the usefulness of ^{99m}Tc-S colloid to the diagnosis of dilated bile ducts on liver scans and infarcts on spleen scans and to the demonstration of impaired vascular supply and replacement of marrow by tumor on bone-marrow scans. (C.H.)

Radiotherapy

Refer also to abstracts 21083, 21159, 21161–21167, 21176, 21274, 21308, 21310–21312, and 21316.

21245 (CONF-700105-1) PRESENT CONCEPTS IN RADIATION THERAPY OF CARCINOMA OF THE UTERINE CERVIX. Marcial, V. A. (Puerto Rico Nuclear Center, [Mayaguez]). [nd]. 7p.

From 22nd Midwinter Radiological Conference, San Francisco, Calif.

The importance of early detection of carcinomas of the cervix is discussed. External irradiation of the whole pelvis with fractionated doses of 4500 or 5000 rads γ radiation administered over a five to six week period, followed within seven to 14 days by intracavitary γ irradiation, using a ^{137}Cs, ^{60}Co, or radium source with loadings that give an output of 50 to 60 rads hr for a total dose of 4000 rads, is recommended as the treatment of choice for carcinoma of the cervix. (C.H.)

21246 (CONF-700105-2) UNORTHODOX DOSE FRACTIONATION TECHNIQUES IN RADIATION THERAPY OF CANCER. Marcial, V. A. (Puerto Rico Nuclear Center, [Mayaguez]). [nd]. 14p. Dep. CFSTI.

From 22nd Midwinter Radiological Conference, San Francisco, Calif.

Clinical results are reported for a number of patients with a variety of neoplasms treated with γ radiation delivered using one, two, or three dose fractions per week. It was concluded that this regime of dose fractionation gave results comparable to those obtained using conventional dose fractionation. The advantages of delivering fewer dose fractions per week to both the patients and radiotherapy personnel are discussed. (C.H.)

21247 THE MANAGEMENT OF THE TEETH, BONE, AND SOFT TISSUES IN PATIENTS RECEIVING TREATMENT FOR ORAL CANCER. Stein, Justin J. (Univ. of California, Los Angeles); James, Arthur G.; King, E. Richard. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 257-68(Feb 1970).

The total needs of the patient with oral cancer must be evaluated preoperatively, during, and after treatment. This can best be accomplished by a team of experts skilled in the diagnosis, treatment, rehabilitation, and in the management of the psychologic and of the socio-economic requirements of the patient. One individual must be responsible for the overall program for the patient. There has been a lack of adequate examinations of the soft tissues, teeth, and bone, and the recording of such data in patients with oral cancer. (29 references.) (auth)

21248 RADICAL RADIATION THERAPY OF CHORDOMA. Pearlman, Alexander W.; Friedman, Milton (University Hospital, New York. Hospital for Joint Diseases Medical Center, New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 333-41(Feb 1970).

Chordoma is a relatively radioresistant tumor which may be destroyed by irradiation alone in only exceptional cases. Complete excision is the treatment of choice. Its applicability is generally limited to tumors arising in the sacrococcygeal region. Surgical cure is achieved in few patients. Most patients with sacrococcygeal chordomas are treated surgically followed by x irradiation for residual or recurrent disease. It is feasible after radical irradiation to excise new recurrences as they appear. Since chordomas grow slowly and remain localized for long periods, this approach has proved practical and effective. Significant palliation can be achieved with irradiation for inoperable tumors. Tumor doses in the range of 7,000 Rads and higher seem to improve the duration and quality of life in a significant percentage of patients, whereas doses less than 4,000 Rads are not likely to be effective. In the higher dose ranges recommended, the risk of radiation injury is real. Repeated courses of irradiation increase the risk. When the first adequate course of irradiation fails, it is not likely that repeated courses will succeed. (auth)

21249 COMPLICATIONS IN 831 PATIENTS WITH SQUAMOUS CELL CARCINOMA OF THE INTACT UTERINE CERVIX TREATED WITH 3,000 RADS OR MORE WHOLE PELVIS IRRADIATIONS. Strockbine, M. F.; Hancock, J. E.; Fletcher, G. H. (Univ. of Texas, Houston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 293-304(Feb 1970).

Complications following radiotherapy of gynecological neoplasms using whole pelvis megavoltage x irradiation before intracavitary radium γ therapy were correlated with various dose levels of whole pelvis irradiation, compactness and loading of radium γ sources, extent of central disease, and other associated factors. The incidence and severity of complications were found to be mostly dependent on the extent of the disease. (auth)

21250 RADIATION THERAPY IN SOFT TISSUE SARCOMAS. Rubenfeld, Sidney; Higgins, George K. (Pack Medical Group and Foundation, New York). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 342-7(Feb 1970).

By means of the cobalt-60 γ beam, a liposarcoma received 6,600 Rads over 31 days, a synovial sarcoma was treated with 6,250 Rads in 52 days, a rhabdomyosarcoma received 4,000 Rads in 37 days, and a mixed mesodermal sarcoma received 5,000 Rads in 30 days. At the time of surgical resection viable tumor was not found and the metastatic pulmonary nodules subjected to radiation therapy completely regressed. The postirradiation microscope studies of the cases presented showed a uniform picture as would be expected from similar dosages, types of tissues irradiated, and the elapse of time between completion of treatment and removal of the irradiated tissues. The picture was that of areas of complete necrosis of all tissues which must have included striated muscle and fibrous tissue as well as tumor. These were surrounded by tissue infiltrated by leukocytes and obviously damaged tissues. In no areas could tumor cells be identified. The relentless fatal course of the disease was not altered in any instance. Although definite conclusions may not be drawn, nonetheless, it is felt that the role of radiation therapy in the management of these soft tissue sarcomas is ready for restudy; perhaps the combination of radiation therapy followed by surgery is warranted. (auth)

21251 PREOPERATIVE VS. POSTOPERATIVE IRRADIATION; COMPARISON IN AN EXPERIMENTAL ANIMAL TUMOR SYSTEM. Perez, Carlos A.; Olson, Judith (Edward Mallinckrodt Inst. of Radiology, St. Louis. Washington Univ., St. Louis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 396-404(Feb 1970).

A comparison was made of the effectiveness of preoperative or postoperative irradiation in the improvement of surgical cures on a group of C3H mice bearing a transplanted 6C3HED Gardner lymphosarcoma. Radiation therapy given before or after the resection of the tumor significantly enhanced the probability of tumor cure in comparison with the operation alone. Preoperative irradiation, at dose levels below 2,000 Rads, was significantly more effective in preventing tumor recurrences than comparable postoperative doses. However, this difference was not detected with doses above 3,000 Rads. (auth)

21252 CARCINOMA OF CERVIX: THE USE OF AN INTEGRATED SYSTEM OF TREATMENT USING A LINEAR INTRACAVITARY RADIATION SOURCE AND EXTERNAL IRRADIATION. Newall, Joseph; Sischy, Benjamin (St. Vincent's Hospital and Medical Center, New York. Highland Hospital, Rochester, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 305-11(Feb 1970).

The advantages of a linear arrangement of radiation sources in the intracavitary irradiation of carcinoma of the uterine cervix are discussed and a ^{137}Cs γ applicator developed on this principle is described. The resultant dosimetry permits a higher contribution to the pelvic lymph nodes than with the applicators customarily available. It is more accurately integrated with the necessary external irradiation by the use of a central wedge filter. The applicator is easy to apply; permits free drainage; and the constant distance from the rectum, together with the incorporated lead screen, has significantly reduced rectal dose. The results of treatment are described. (C.H.)

21253 SIGNIFICANCE OF POSTOPERATIVE IRRADIATION IN CARCINOMA OF THE CERVIX: A TEN YEAR SURVEY. Guttmann, Ruth (Francis Delafield Hospital, New York). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 102-8 (Jan 1970).

Total pelvic irradiation with a tumor dose of 4,000 to 5,000 Rads delivered in four to five weeks time was tolerated extremely well and the late complications were rare in a group of patients with carcinoma of the cervix treated following radical hysterectomy with 2 MeV x radiation. The results were encouraging: 39 of the 50 patients have lived more than five years, while 22 of the 43 patients who have been followed for a minimum of 10 years are living and well. (C.H.)

21254 STACK SCANNING: GUIDES TO VIEWING. Dockray, Karl Thord (Univ. of Arkansas, Little Rock). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 412-15(Feb 1970).

Because the human eye cannot appreciate gross contrasts occurring in targets with high or low optical density, any alteration bringing the display into a detectable range becomes helpful. Simultaneous multi-film radioisotope scan recordings do this. Subtle contrasts in the composite display are enhanced by the reduction of glare, by rapid eye movements over faint zones of density change, and by stereoscopic viewing. (C.H.)

21255 CALCIFICATION OF THE BASAL GANGLIA FOLLOWING RADIATION THERAPY. Harwood-Nash, D. C. F.;

Reilly, B. J. (The Hospital for Sick Children, Toronto). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 392-5(Feb 1970).

The association of bilateral basal ganglia calcification subsequent to therapeutic irradiation of the cranial vault and brain has not been previously recorded. A description is presented of such a relationship in two children, one of whom had a hypothalamic glioblastoma multiforme and the other histiocytosis of the skull. The calcification was detected roentgenographically three and nine years following γ irradiation, at which time both children were 12 years of age. There was no disturbance of calcium or phosphorus metabolism in either child and no roentgenographic evidence of calcification of the basal ganglia prior to irradiation. The pathogenesis of the calcification is likely to be local tissue hypoxia resulting from radiation damage to the small vessels of the basal ganglia. (auth)

21256 TOTAL ABDOMINAL IRRADIATION USING ^{60}Co MOVING STRIP TECHNIQUE. Friedman, Asa B.; Benninghoff, David L.; Alexander, Leslie L.; Aron, Bernard S. (State Univ. of New York, Brooklyn. Kings County Hospital Center, Brooklyn). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 172-7 (Jan 1970).

Twenty patients with advanced abdominal dissemination of ovarian carcinoma and seven patients with intra-abdominal disseminated lymphoma were treated with moving strip ^{60}Co γ therapy techniques, administering 3,000 R depth dose in 10 days time to each strip area. This dose is probably close to the maximum tolerated dose in the average case and unfortunately beyond that in some cases. This method is clinically more effective and the results, although poor enough, are more encouraging than those obtained when using large abdominal field techniques. The inherent dangers of this method are significant hematopoietic and acute gastrointestinal reactions. (auth)

21257 EXTERNAL IRRADIATION FOR GYNECOLOGIC MALIGNANT TUMORS. Kasamatsu, Tatsuhiro; Nakanishi, Takashi (National Cancer Center, Tokyo). Sanfujinka No Sekai; 21: 895-901(Sep 1969). (In Japanese).

Techniques and indications for external irradiation for carcinoma of the uterine cervix, uterus, ovary, vulva and chorionepithelium are reviewed. The equipment discussed includes that for orthovoltage x-ray, telecobalt, telecesium, linear accelerator and betatron. In single radiotherapy of uterine cervix carcinoma, the standard dosage is 1000 R per week divided in 5 to 6 times with the maximum dose of 4000 to 5000 R in 4 to 5 weeks. RI is desired to be ^{60}Co or those with higher energy. External irradiation was used in cases in which intravaginal irradiation is difficult at the initial stage of treatment due to hemorrhage, infection or other reasons. The field generally corresponds to the region for operation and lymphography is considered to be useful in deciding the field size. In surgical cases, postoperative irradiation with the minimum dose of 4000 R is suggested. In advanced uterine carcinoma for which surgical operation is impossible, palliative irradiation of the pelvic cavity with 5000 R proved to be effective in prolonging remission. Carcinomatous remnants in the pelvis in metastatic ovarian carcinoma is an indication for external irradiation. Primary radiotherapy using betatron was given to vulvular carcinoma that was surgically treated. (NSA of Japan)

21258 RADIOIODINE FOR THYROID CANCER. Sisson, James C. (Univ. of Michigan, Ann Arbor). New Engl. J. Med.; 281: 618-19(11 Sep 1969).

The possibility that a reduction in the I pool made the same dose of ^{131}I therapeutically more effective for carcinoma was discussed. A depletion in the I pool of normal subjects was accompanied by an increase in the per cent uptake of ^{131}I by thyroidal tissue while the renal clearance of ^{131}I returned to normal. This has not been studied in the hypothyroid person, nor has it been shown to be a consequence of ethacrynic acid administration. The renal plasma flow in hypothyroid subjects may have been reduced by ethacrynic acid, so that a greater per cent of ^{131}I was retained not only in thyroid tissue but also by the body as a whole. The net effect would be the same as increasing the number of mCi in the treatment. No excretion data were presented on the effects of diuresis. The intrinsic mechanism in normal thyroid cells that facilitated the adaptation to a depleted I pool did not exist in neoplastic tissue. The tissue that was evaluated in the uptake studies was not elucidated. Basal uptakes of 9% or more of the dose were achieved to a large extent by normal tissue. The study included two patients with medullary carcinoma, two with undifferentiated cancers, and one with lymphoma. Since these neoplasms have not been shown to concentrate ^{131}I, the propriety of investigation and treatment of an area near the primary lesion with ^{131}I was questioned. (BBB)

21259 PALLIATIVE RADIATION THERAPY IN PATIENTS WITH CANCER OF THE COLON AND RECTUM. Whiteley, Horace W. Jr.; Stearns, Maus W. Jr.; Leaming, Robert H.; Deddish, Michael R. (Memorial Hospital, New York). Cancer; 25: 343-6(Feb 1970).

Radiation therapy given expertly and in moderate tumor-dose courses is recommended for the control of symptoms in patients with nonresectable cancer of the colon and rectum. In this review of 165 patients undergoing palliative radiation therapy, more than 50% had definite symptomatic and objective response. Over 80% of patients with localized disease, particularly intrapelvic, received significant palliation. (auth)

21260 SOFT-TISSUE SARCOMA. TREATMENT WITH METHOTREXATE AND RADIATION. Brenner, Seymour M.; Miller, Sherwood P.; Custodio, Deogracias. N. J. State J. Med.; 70: 855-60(1 Apr 1970).

Fifteen consecutive patients with a malignant soft somatic tumor were treated. Nine patients had a rapid downhill course without any evidence of response to treatment. Six patients appeared to have benefited from the treatment used. Five of the six responders were treated with a combination program of methotrexate and γ radiation therapy. The sixth was treated with radiation therapy alone. The median survival of patients treated with the combined program was nineteen months, compared with a median survival of two months in the group of patients treated with various other modalities. (auth)

21261 RADIATION THERAPY. Umegaki, Yoichiro (National Cancer Center, Tokyo). Shindan To Chiryo; 57: 1855-62(Oct 1969). (In Japanese).

Recent progress in the study of the mechanism of radiation effects in tumors and techniques and equipment for cancer radiotherapy are outlined. The high energy radiotherapy, mainly supervoltage and telecobalt, have been widely enough used to be established as reliable therapeutic methods for tumors, particularly of the larnyx and lung. The extended use of betatron introduced electron beams to the treatment of tumors of the skin, neck and head and urinary bladder. A new therapeutic method has been developed for urinary bladder cancer: direct irradiation with electron beams to tumors exposed by surgical operation. Attempts have been made to apply this method to tumors of the intraperitoneal cavity to achieve at least palliative effects. The studies are being undertaken for the development of new radiation sources with better dose distribution and less oxygen effect utilizing the possibility of biological selection. In addition to the improvement of the techniques for controlling dose distribution, electronics and computers have been applied to facilitate the instantaneous establishment of therapeutic plans and the control of equipment. The improvement of the effectiveness of radiotherapy is best exemplified by BAR method for brain tumors and also for upper maxillary tumors in which BUdR or other radiosensitizing agents are given in intra-arterial injection prior to irradiation. Administration of an antimetabolite proved to increase the effectiveness of this method. (NSA of Japan)

21262 THE PRESENT STATUS OF LASER IN MEDICINE. Siler, Vinton E. (Univ. of Cincinnati). Postgrad. Med.; 46: 82-6(Aug 1969).

Laser is a new form of radiation which may prove a useful biomedical tool. Since it is in its infancy, more basic research by physicists, engineers, biochemists, physiologists and physicians will be required to assess its application as a safe modality in the field of clinical medicine. Results of gross and cellular tissue studies have been inconclusive because the unit dosage of laser radiation has not been standardized as yet. As a laboratory tool, laser has inherent dangerous properties warranting fully controlled experimentation and protection of all personnel. As an experimental tool, laser should be studied further in laboratory centers by competent investigators. At present, the use of laser in clinical medicine is limited and should continue to be restricted until basic animal research proves beyond doubt its real value in altering pathologic processes in man. Laser may show promise in certain opthalmologic conditions such as control of hemorrhage in diabetic retinopathy and correction of detached retina. Laser has eradicated superficial pigmented skin lesions such as tattoos and port-wine lesions. Since it has not yet proved of real value in oncology, conventional methods of surgery and radiation should be used to treat and control malignant tumors. Experimental studies with continuous-wave laser may lead to development of a new surgical instrument capable of performing bloodless operative procedures heretofore considered impossible. (auth)

21263 APPLICATION METHOD OF TREATMENT USING ^{147}Pm FOR INFLAMMATORY DISEASES OF THE CORNEA. Sviridenko, S. G. Oftal'mol. Zh.; 23: 132-5(1968). (In Russian)

The paper presents results of beta-ray therapy with promethium 147 carried out in 96 patients (105 eyes) with various inflammato

diseases of the cornea, such as herpetic keratitis, lesions of the cornea in the presence of adenovirus keratoconjunctivitis, ulcers of various etiology, traumatic and marginal infiltrates. Promethium-147 has been firstly used in opthalmic practice. This isotope is a pure beta-irradiant with a 2 to 6 year period of a semibreak off. Irradiation of promethium-147, in contradistinction to the sources of beta-irradiation so far used in opthalmology, is completely absorbed by the outer sheath of the eye, and the danger to effect underlying tissues is fully avoided. Irradiation with promethium-147 was carried out using relatively small single doses (25–30 rad) and summary ones (in most of patients at the range of 300 rad). The treatment with Pm-147 proved to be effective for dendritic type of keratitis, adenovirus keratitis, traumatic and marginal infiltrates. Less effective it appeared to be in cases of a disc-shaped herpetic keratitis, profound piogenic ulcers of the cornea. (auth)

21264 RADIATION-DAMAGED NAIL. Ronchese, Francesco. Cutis (N. Y.); 3: 1304-5(1967).

Classic radiation damage to the nail, the kind seen in the roentgenologist and the roentgen technician, in the dermatologist, the gastroenterologist-protologist, and the veterinarian, is described and illustrated. Photographs show the damaged hand of a veterinarian resulting from setting the fractured bones of dogs without protection. Others show the damaged fingertips of a gastroenterologist. Occasionally a deformed nail may result from the use of radiation to remove a wart, evidently from an overdose. Surgery or the penetration of an electrocoagulating needle too deeply to remove a wart may also result in a permanent nail deformity. An example is cited to illustrate the potential for resistance and healing of human tissues, which are often underestimated. In 1945, a dental technician put the warty tip of a friend's right little finger under a dental x-ray machine for an undetermined, but long, time. A severe dermatitis followed, persisted for years, but finally subsided. Twenty years later, photographs show that the right little finger and nail are conspicuously different from the normal-appearing left little finger and nail. The devitalization caused by heavy radiation produced the deformity but left a finger functioning almost normally and without discomfort. (BBB)

21265 BASIC PRINCIPLES OF DERMATOLOGICAL APPLICATION OF SOFT AND ULTRASOFT X RAYS IN THE TREATMENT OF MALIGNANT SKIN TUMORS. Ueno, Kenichi (Tokyo Medical Coll.). Hifuka No Rinsho; 11: 757-76(Oct 1969). (In Japanese).

The data on 278 patients with skin tumors treated with soft or ultrasoft x irradiation using Dermopan in the period of 4 years and 2 months from 1964 through 1968 are reviewed. The total number of irradiated fields was 734 including 284 malignant tumors (67 cases). (NSA of Japan) (TSS)

Blast and Thermal Effects

21266 NEURO-MUSCULAR TESTS OF AGING IN HIROSHIMA SUBJECTS. Hollingsworth, Dorothy R.; Hollingsworth, J. William; Bogitch, Seymour; Keehn, Robert J. (Atomic Bomb Casualty Commission, Hiroshima). J. Gerontol.; 24: 276-83 (Jul 1969).

As part of studies to determine whether there are perceptible differences in the aging of atomic bomb survivors who were exposed to widely differing amounts of radiation, 3 tests of neuromuscular function were administered to subjects attending the clinic of the Atomic Bomb Casualty Commission in Hiroshima, Japan. All 3 readings (strength of hand grip, reaction time in a light-extinction test, and the voltage required to detect vibration) clearly varied with age. No changes definitely related to radiation exposure were detected. Only for hand-grip strength was there evidence that the relation between age and test score varied significantly between exposure groups, but no significant association between grip strength and rad-dose was found in subjects within 2,000 m of hypocenter. The differences between exposure groups are more likely to have resulted from socioeconomic variation by geographical area than from variation in the level of radiation. (BBB)

Radiation Effects on Animals

Refer also to abstracts 21123, 21202, and 21203.

21267 (NP-18090) THE STRANGEWAYS RESEARCH LABORATORY. Report for 1968. (Strangeways Research Lab., Cambridge (England)). 64p. Dep. CFSTI (U. S. Sales Only).

Research in radiobiology consisted of studies on the effects of antiserum on Chinese hamster fibroblasts and its influence on sensitivity of cells to x radiation and studies on changes in x-radiosensitivity of the developing rat eye. Other studies are reported on the cell surface of erythrocytes, lymphoid cells and macrophages, biochemistry of connective tissue, developmental biology and histology, reproductive physiology, pathology, and cancer. (H.L.W.)

21268 ROLE OF PHOSPHATE AND PHOSPHOPROTEIN IN THYMOCYTE INTERPHASE DEATH. Betel, I.; Appelman, A. W. M.; Graver, M. A. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Exp. Cell Res.; 59: 97-104(Jan 1970).

According to Whitfield's hypothesis, interphase death in the thymocytes results from accumulation of phosphate and from increased phosphoprotein synthesis in the nucleus which is caused by an inhibition of nuclear oxidative phosphorylation. The experiments described in this paper provided no evidence either for phosphate accumulation or for increased protein phosphorylation under the conditions predicted by the hypothesis. One and two hours after x irradiation with 800 Rads and incubation in a medium containing 30 mM phosphate, the intracellular phosphate content and the amount of protein-bound phosphate had not changed. Also the exchange of phosphate with the medium had not changed while the labeling of protein-bound phosphate seemed to be slightly inhibited. Addition of 5×10^{-4} M dinitrophenol after irradiation decreased the appearance of pycnotic nuclei and strongly increased the intracellular phosphate content but had no effect on the amount or labeling of protein-bound phosphate. Oligomycin did not influence phosphoprotein labeling, it inhibited phosphate exchange between cells and medium but did not increase pyknosis; on the contrary it inhibited radiation-induced pyknosis to a greater extent than did dinitrophenol. Cortisol increased pyknosis without any effect on phosphate and phosphoprotein, and this increase was inhibited by dinitrophenol. Valinomycin had no inhibitory effect on nuclear phosphorylation and did not increase intracellular phosphate and phosphoprotein; it did increase the rate of pyknosis. It was concluded that the mechanism initiating interphase death in irradiated thymocytes remains unknown. (auth)

21269 RADIOSENSITIVITY OF MAMMALIAN CELLS. I. TIMING AND DOSE-DEPENDENCE OF RADIATION-INDUCED DIVISION DELAY. Walters, R. A.; Petersen, D. F. (Los Alamos Scientific Lab., N. Mex.). Biophys. J.; 8: 1475-86 (Dec 1968).

The time of onset and duration of division delay induced by exposure to 250 KVP x irradiation were measured in several mammalian cell lines grown in suspension culture. Irradiation exposures were delivered at rates of 50 to 150 rad/min. Readings were converted to absorbed dose at the center of each flask after correcting for attenuation of the beam by the solution. Unique times of action (i.e., interval from irradiation to cessation of division) late in G_2 were characteristic for HeLa, L-5178Y, and Chinese hamster cells, and the time of action was independent of dose over the range 25 to 800 rad. The duration of delay was directly proportional to dose. All irradiated cells divided at least once and maintained their relative positions in the life cycle for periods exceeding one generation time. Neither random nor synchronous cultures exposed at varying times in the life cycle exhibited differences in radiation sensitivity measured either by onset or duration of the delay period. The time of action was experimentally indistinguishable from the point marking completion of protein synthesis essential for division. This led to speculation that division delay involved a translation defect. (BBB)

21270 RADIOSENSITIVITY OF MAMMALIAN CELLS. II. RADIATION EFFECTS ON MACROMOLECULAR SYNTHESIS. Walters, R. A.; Petersen, D. R. (Los Alamos Scientific Lab., N. Mex.). Biophys. J.; 8: 1487-1504(Dec 1968).

Radiation effects on macromolecular synthesis essential for the Chinese hamster cell to traverse the life cycle and to divide were investigated. Life-cycle analysis techniques employing inhibitors of macromolecular synthesis were used in determining the kinetics of cell growth for specific segments of the population following spontaneous recovery from radiation-induced division delay. The results indicated that recovery did not occur in the absence of functional protein synthesis. Under conditions which inhibit normal RNA and DNA synthesis, irradiated cells could recover the capacity to traverse the life cycle and to divide. The stability of mRNA species coding for proteins essential for division in irradiated cells was also measured. The mean functional lifetime of these mRNA species was 1 hr. The data demonstrated the existence of a specific segment of the population consisting of cells which have completed transcription related to division but not concomitant translation and which could recover from the radiation injury without synthesis of additional RNA. Thus, initial recovery of the ability to divide had an obligate requirement for protein synthesis but

no corresponding requirement for nucleic acid synthesis during the period when original messenger remained intact. (BBB)

21271 THE ROLE OF NUCLEAR DAMAGE IN RADIATION-INDUCED LETHALITY OF SYNCHRONIZED CHINESE HAMSTER CELLS. Mantsygin, Yu. A.; Bagrova, A. M.; Shapiro, N. I. (Moscow State Univ.). Genetika; 5: No. 12, 49-61(Dec 1969). (In Russian).

The role of nuclear damage in radiation-induced (reproductive) death of the synchronized somatic cells of Chinese hamster in vitro (stages G_1 and late S) was studied. When modifiers of the radiosensitivity (5-bromodeoxyuridine, cysteamine) were used, different doses of radiation (differing by an order) resulting in the same lethality of cells were found. It was shown that irradiation at these doses caused constant chromosome aberrations that were of the same yield. The number of survivors correspond well to the number of metaphases not containing chromosomal aberrations in the first mitosis after irradiation. These data suggested that radiation-induced (reproductive) death of somatic cells of Chinese hamster is determined almost completely by radiation-induced damage of nuclear structures. The study of the radiosensitivity of different stages of mitotic cycle showed that the late S stage was more resistant than G_1. Moreover, it was shown that radiosensitization by BUdR incorporated into both strands of DNA was more expressed when cells were irradiated at the late S stage than at G_1. These data are discussed with regard to the nature of radiosensitivity of different stages of the mitotic cycle and modifying action of BUdR and cysteamine. (auth)

21272 RADIOSENSITIVITY OF EOSINOPHILS IN LYMPHOCYTE CULTURES FOLLOWING STIMULATION WITH ANTI-LYMPHOCYTE SERUM OR PHYTOHEMAGGLUTININ. Hartweg, H.; Renner, H.; Renner, Kh. (Univ., Basel). Strahlentherapie; 139: 37-9(Jan 1970). (In German).

In smears from lymphocyte cultures, the number of eosinophils was determined after stimulation. Stimulation with antilymphocytic serum results in a marked elevation of the eosinophils, more than after a stimulation with phyto-hemagglutinin. The number of eosinophils does not decrease after irradiation with 10, 100 or 500 Rad. The number of all cells is reduced after irradiation in a phyto-hemagglutinin culture. (auth)

21273 ANALYSIS OF NORMAL AND IRRADIATED HUMAN LEUCOCYTE PROLIFERATIVE KINETICS BY MEANS OF THE MICROSPECTROPHOTOMETRIC DETERMINATION OF DNA. Benassi, E.; Piccotti, F. (Univ., Turin). Strahlentherapie; 139: 40-2(Jan 1970).

Microspectrophotometric methods are used for study of DNA in normal and irradiated leukocytes. Only after 72 hours an irradiation effect is shown. (auth)

21274 CYTOCHEMICAL AND PROLIFERATION KINETIC FINDINGS IN PERIPHERAL BLOOD FOLLOWING THERAPEUTIC IRRADIATION. Chone, Bruno; Rose, Peta v. (Univ., Heidelberg). Strahlentherapie; 139: 21-36(Jan 1970). (In German).

Seventy-six patients were studied after partial irradiation with doses of 5000 to 6000 R. The study concerned peripheral blood, especially the cytochemical modifications and the labeling, after irradiation, changes in the last maturation stage of the blood cells. The labeling was made in vitro with tritiated thymidine (2 microcuries, specific activity 14.2 Ci/mMol). In order to increase the statistical significance and to facilitate the differential cell counting, leukocytes were concentrated by the dextraven-method. The cytochemical study object was the leukocyte alcaline phosphatases. The autoradiographs were obtained by the stripping-film method. The evolution of the index of the l.a.p. shows a wide variation. After radiotherapy no characteristic variations were found. The circulating lymphocytes and the monocytes showed large variations, but with a careful and systematic study relating to the diagnosis and the region irradiated, certain associations can be found: partly a statistical modification of the labeling index in both cellular populations, and in function of the dose delivered. Stimulation of the bone marrow with Echinacin was also investigated. (auth)

21275 RADIATION EFFECTS ON LYMPH NODES: AN ELECTRON MICROSCOPIC INVESTIGATION. Holsten, Dietrich Robert (Medizinische Hochschule, Hanover). Strahlentherapie; 139: 51-72(Jan 1970). (In German).

Rats received a total body irradiation of 1000 or 3000 R. The inguinal and paraaortic lymph nodes were removed and studied in the electronmicroscope. Fixation was done with OsO_4 or formol-uranylacetate or glutaraldehyde; contrast was obtained by staining with lead hydroxide. The earliest lesions in the cell are chromatin dissociation, dislocation of the cytoplasmic membrane of the nucleus, folds in the membrane near the nucleus and agglomeration of the hyoplasma. The cellular lesions after 3000 R total body are much more pronounced. Cellular death appears mainly as pycnosis, caused by agglomeration and precipitation of chromatin and nuclear material. The perinuclear cisternae are dilatated. Precipitation occurs in the hyaloplasma. The cellular and nuclear membrane breaks down with increasing damage. The lymphocyte seems the most sensitive cell, followed by the lymphocyte series, the differentiated reticulum cells and the precursors of the plasma cells. The plasma cell has the lowest sensitivity. The modifications in the reticulum cells can be regarded as caused by direct damage and by the enhancement of phagocytosis. It is difficult to distinguish between these two mechanisms. When the DNA content is followed in the lymphocyte after aldehyde-fixation, no loss of DNA is found. In the plasmocyte there is a reduction of the number of ribosomes. The phagocyting lymphocytes are lost by two mechanisms: a vacuolisation and a liquefaction of the nuclear substance with formation of a fine granular material. The nuclear lesions are preponderant in the electronmicroscope after 1000 or 3000 R. (auth)

21276 STUDIES OF HeLa CELLS EXPOSED EITHER SINGLY OR COMBINED TO STEROIDS AND X RADIATION. Peters, K.; Bauer, R. (Univ., Tuebingen, Ger.). Strahlentherapie; 139: 43-50(Jan 1970). (In German).

Progynon-B, testosterone (Ciba and Schering), and radiations up to 200 R, have no influence on the number of Barr-positive cells in Hela-cells cultures. The testosterone, however, increases the number of middle- and peripheral chromocenters. The association of testosterone and radiation does not increase this effect. (auth)

Invertebrates

Refer also to abstracts 21107, 21119, 21128, 21129, and 21133–21135.

21277 EFFECTS OF GAMMA-IRRADIATIONS ON DEVELOPMENT OF SILKGLANDS AND SILK FORMATION OF THE SILKWORM, BOMBYX MORI L. Shigematsu, Hajime; Takeshita, Hiroo (Sericultural Experiment Station, Tokyo). Norin-sho Sanshi Shikenjo Hokoku; 23: 121-48(Nov 1968). (In Japanese).

The effects of exposure of eggs or embryos of silkworms, Bombyx mori, to doses of γ radiation ranging from 1,000 to 2,980 R on cell division and silk formation by silk glands were studied. A relationship was found between the number of cells surviving after exposure to γ radiation, the effects of dose rate, and the formation of silk. (NSA of Japan) (C.H.)

21278 BIOLOGICAL EFFECT OF ELECTRON BEAM IRRADIATION ON SMALL CREATURES. I. Motomura, Isao; Yamamoto, Masahiko (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 92-3(1968). (In Japanese).

Using adult newts and developing echinus spawns, the biological effects of electron beams on small animals were investigated. A lead cylinder of 5 cm diameter and 5 cm height was put under the irradiated sample, and by the electric current generated, the dosage of 60 MeV electron beam was controlled. Both the newts and the echinus spawns were put into plastic cylinders of 2 cm diameter and 7 cm high, which was set in water at intervals of 5 cm, and the various dosages of electron beams were controlled by a water filter. Both male and female newts irradiated by the electron beam died during irradiation or several hours following irradiation. The change of their motility suggested lesions of the nervous system. Less dosage caused typical radiation lesions. In both cases, secretion of white mucus from the body surface was observed following irradiation. (NSA of Japan)

21279 BIOLOGICAL EFFECT OF ELECTRON BEAM IRRADIATION ON SMALL CREATURES. 2. CHANGE IN THE DIGESTIVE CANAL OF NEWTS DUE TO 60-MeV ELECTRON BEAM. Yamamoto, Masahiko; Motomura, Isao (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 143-7(Dec 1968). (In Japanese).

Electron beams of 60 MeV and 0.5 μ Coulomb were used for irradiation of male and female newts. The intensity of the electron beam was controlled by using a water tank of a certain width. Following irradiation, the digestive organs were fixed with Bouin solution, paraffined, and sliced. After dyeing with Azan, they were observed through a microscope and the following results were obtained: newts, directly irradiated by the electron beam of 0.5 μ Coulomb, died after several hours following irradiation. Within this period the tissue of their digestive organs changed. The newts, irradiated through the filter of a water tank of 72 mm width, survived for five days after the irradiation, but formation of vacuole on the mucous epithelial cells of the digestive tracts was observed. The newts, irradiated through the filter of water tank of 144 mm width survived for ten days after the irradiation, and the change of organs was less apparent. In the mucous epithelial cells, however, a big vacuole that was not dyed with Azan, was formed. (NSA of Japan)

Vertebrates

Refer also to abstracts 21073, 21074, 21079–21081, 21085–21088, 21092, 21116, 21117, 21120, 21122, 21127, 21204–21207, 21209, 21210, 21212–21218, 21269, and 21270.

21280 (COO-1486-5) SEASONAL EFFECTS OF LIGHT, TEMPERATURE, AND RADIATION ON ACTIVITY PATTERNS OF THE MEADOW VOLE (MICROTUS PENNSYLVANICUS). Final Report. Evans, Francis C. (Michigan Univ., Ann Arbor. Dept. of Zoology). Jan 1970. Contract AT(11-1)-1486. 20p. Dep. CFSTI.

Use of a continuously rotated scintillation probe to detect the position of radioactively (^{182}Ta) tagged meadow voles (Microtus pennsylvanicus) was shown to be a feasible and accurate method of recording small mammal activity in field enclosures. The technique permitted the observation of individual animals at all times of year and yielded a better characterization of vole activity than had previously been available. The meadow vole was shown to possess a strong rhythm in its activity, with about six or seven 1 to 3 hr periods in the course of the 24 hr cycle, so adjusted that one period usually occurs at dawn and one at dusk. It is on the whole a diurnal animal, with generally higher levels of activity in the daytime than at night and with more of its total activity concentrated between sunrise and sunset. Seasonal adjustments occur, with a reduction in activity in winter. Correlation of activity with length of photoperiod, light intensity, and temperature was weak, however, and in general meteorological factors did not seem to have major effects in modifying the pattern of activity. Confinement to cages results in a marked reduction in activity, in more nocturnal behavior, and in less synchrony in the timing of activity bursts. When caged under conditions of continuous light and constant temperature, a vole may show a very low level of activity and complete loss of synchrony. (auth)

21281 (NYO-2785-4) THE TUMORIGENIC ACTION OF BETA, PROTON, ALPHA, AND ELECTRON RADIATION ON THE RAT SKIN. Progress Report, April 1, 1961–March 31, 1970. Albert, Roy E. (New York Univ., N. Y. Dept. of Environmental Medicine). Contract AT(30-1)-2785. 37p. Dep. CFSTI.

Previously reported research consisted of studies on dose response relationship for tumor induction; effects of irradiation in a grid or sieve pattern on tumor incidence; effect of penetration depth on tumor incidence; correlation between tumor incidence and hair follicle damage; the RBE of alpha particles with respect to electrons for tumor induction; and morphology and growth characteristics of radioinduced skin tumors in the rat. Research in progress is reported on the effect of pore size on tumor induction in rat skin by proton irradiation in a sieve pattern; the effect of hole size and spacing on hair follicle damage produced by sieve pattern irradiation; the comparative skin tumor and injury response to soft x rays and other forms of ionizing radiation in rats; the basis for the low susceptibility of the mouse to radioinduced skin tumors; theoretical considerations and experimental techniques for the demonstration of a G_0-phase in epidermis; DNA loss and replacement in irradiated skin; the incorporation of BUdR into the DNA of skin; the effect of dose fractionation on tumor induction in rat skin, tumor induction by freezing; and the use of croton resin to promote radiation-initiated tumors. (H.L.W.)

21282 (THAI.-AEC-13) THE EFFECT OF GAMMA RADIATION ON THE HATCHABILITY, RATE OF GROWTH, AND REPRODUCTION OF THE FISH, TRICHOGASTER PECTORALIS, REGAN. Chakpitak, Saovanee (Office of Atomic Energy for Peace, Bangkok (Thailand)). 1967. 11p. (In English and Thai). Dep. CFSTI (U. S. Sales Only).

A preliminary study of the effect of gamma radiation on the hatchability, rate of growth and reproduction of the fish, Trichogaster pectoralis, has been made. Results showed that the hatching time of eggs became shorter when adult fish in spawning stage were exposed to low doses of irradiation (750 to 1500 rads). A decrease in the percentage of hatchability was observed at a dose of 2250 rads. In general, the percentage of survival and rate of growth of fish from irradiated parents were better than those of the control. The difference was statistically significant when a dose of 2250 rads was used. (auth)

21283 ESCAPE/AVOIDANCE AND PUNISHMENT BEHAVIOR IN THE RAT AFTER FETAL X-IRRADIATION. Martin, Joan C. (Duke Univ., Durham, N. C.). Radiat. Res.; 41: 614-22(Mar 1970).

Osborne–Mendel rats that were whole-body x-irradiated on one of days 17, 19, or 21 of gestation with 196 R, exhibited significantly more bar press escape/avoidance responses as a function of increasing shock intensity than did sham-irradiated controls. In a two-bar punishment paradigm, irradiated rats initiated significantly fewer shock-on periods and made a greater number of responses during time-out as compared with time-in periods as a function of increased shock intensity. (auth)

21284 EFFECTS OF IONIZING RADIATION AND VINBLASTINE ON THE PROLIFERATION OF PERITONEAL MACROPHAGE PRECURSORS IN THE MOUSE. Chen, Michael G.; Schooley, John C. (Univ. of California, Berkeley). Radiat. Res.; 41: 623-36(Mar 1970).

The bone marrow-derived precursors of macrophages and monocytes in inflammatory peritoneal exudates in the mouse are radiosensitive and vinblastine-sensitive cells. The degree of sensitivity to these two agents is comparable to that reported for other hematopoietic progenitor cells and for cells mediating various parameters of the immune response; this is in contrast to the known radio- and drug-resistance of the mature macrophage. The rate and timing of recovery of these macrophage precursors after 80 μg vinblastine is similar to the patterns of recovery of erythropoietin-sensitive cells after the drug. (auth)

21285 MAMMALIAN GAMETOGENESIS AND SPECIES COMPARISONS IN RADIATION RESPONSE OF THE GONADS. Oakberg, E. F. (Oak Ridge National Lab., Tenn.). pp 3-15 of Effects of Radiation on Meiotic Systems, Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

Primordial germ cells have an extra-gonadal origin and migrate to the genital ridge early in embryonic development. After a series of mitoses, they transform into oocytes in the female and into type A spermatogonia in the male. In females, the total supply of germ cells is present either before or shortly after birth; development of the oocyte is arrested in diplotene of meiotic prophase. The nuclear characteristics of the "arrested" diplotene varies greatly between species, and is an important factor in species differences in ovarian radiation response. In adults of all mammals, the radiation response of the ovary involves a fixed population of primary oocytes. Oogonia are absent; any loss from the oocyte pool cannot be replaced. Type A spermatogonia persist throughout the reproductive life span of the male, and a complete array of gametogenic stages is present in the adult. Radiation resistance of spermatids and sperm results in an initial period of post-irradiation fertility; destruction of spermatogonia and possibly spermatocytes leads to oligospermia with doses of several hundred R; fertility eventually returns owing to repopulation of the seminiferous epithelium from a few surviving type A spermatogonia. The different radiation response of males and females therefore can be attributed to basic differences in gametogenesis and the array of germ cell stages present in the adult gonad. A radiation response typical for all males also occurs in man. However, exact comparison of radiation sensitivity in man and experimental animals is not possible owing to differences in the control of spermatogonial differentiation which results in species differences in both initial depletion and subsequent recovery of the spermatogonial population. (auth)

21286 TEMPORARY SPONTANEOUS REGRESSION OF ISOLOGOUS TUMOR TRANSPLANTS IN IRRADIATED TISSUE. Seydel, H. Gunter; Sloan, Kenneth; Berk, Sanders (Univ. of Maryland Hospital, Baltimore. American Oncologic Hospital, Philadelphia). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 178-83(Jan 1970).

Although the exact nature of the tumor bed effect remains unclear, retardation of capillary formation and functional changes in the vascular bed remain the most likely mechanisms for the decrease in growth of tumor in irradiated tissue. Connective tissue changes such as increased deposition of collagen and hyaline material or fibroblast proliferation may be contributory factors. The temporary regression observed in experiments on the growth of mammary carcinoma transplants in x-irradiated mice may be related to the time sequence of histologic and functional radiation changes in the tumor bed; however, experimental evidence for this is lacking as yet. On the other hand, these investigations offer experimental support for the clinical experience that the tumor bed affects the response of human tumors to radiotherapy. (auth)

21287 VASCULAR ALTERATION IN THE IRRADIATED RABBIT KIDNEY, A MICROANGIOGRAPHIC STUDY. Scanlon, Gerard T. (Marquette School of Medicine, Milwaukee). Radiology; 94: 401-6(Feb 1970).

Microangiography was used to study both the early and late changes in the rabbit kidney induced by x irradiation. In the more severe stages there is intense curling and spiraling of arterioles with obliteration of most of the glomeruli. Contrast material (and presumably blood) goes through the kidney without passing through a glomerulus. In the early stages there appears to be a shunting

of contrast medium through the medullary portion of the kidney at the expense of the peripheral glomeruli. (auth)

21288 EFFECT OF X IRRADIATION ON VASCULARITY OF NORMAL TISSUES AND EXPERIMENTAL TUMOR. Song, Chang W.; Levitt, Seymour H. (Medical Coll. of Virginia, Richmond). Radiology; 94: 445-7(Feb 1970).

Vascular permeability to plasma protein in Walker 256 tumors of rats as determined by counting the activity of ^{51}Cr and ^{131}I in blood and tissue samples obtained one hour following injection in a mixture of ^{51}Cr-labeled erythrocytes and ^{125}I-labeled human serum albumin, was about 20 to 30 times that in the skin or muscle. Relative vascular volume in the bigger tumors was less than that in the smaller tumors. After single exposure with 3,000 and 6,000 R of x rays, vascular volume in tumors decreased whereas it increased in the skin and muscle. (C.H.)

21289 EFFECT OF IRRADIATION ON TUMOR-INFUSED LYMPH NODES. O'Brien, Paul H.; Moss, William T.; Ujiki, Gerald T.; Putong, Paul; Towne, William (Northwestern Univ., Chicago). Radiology; 94: 407-11(Feb 1970).

The lateral aspect of the left hind limb of 70 New Zealand white rabbits was x irradiated under general anesthesia. The rabbits were divided into three groups: control, 1,000 rads, and 3,000 rads. V_2 cancer cells were infused into the afferent lymphatic of the popliteal lymph node of the animals. In controls the node acted as a barrier to tumor spread for up to three weeks. Ionizing irradiation significantly increased distant tumor growth in the animals. (auth)

21290 INFLUENCE OF ^{90}Sr INJECTION ON ENDOCRINE GLANDS OF MICE IN PREGNANCY. Tanaka, Tetsuya; Muto, Tatsukichi (Mie Prefectural Univ., Tsu, Japan). Mie Med. J.; 18: 273-7(Jan 1969).

The effects of a radioisotope on the endocrine glands of pregnant mice and its effects on the development of fetuses were investigated. Mice were divided into three groups according to the dosage of ^{90}Sr; two mice were injected with 1.5 $\mu c/g$, one on the 6th day of pregnancy, and the other on the 10th day; three mice were given 3.0 $\mu c/g$, one on the 5th day and the other two on the 11th day; and one mouse was injected 5.0 $\mu c/g$ on the 11th day of pregnancy. Atrophy of endocrine glands was observed in general, however, the pathological changes were most marked in the thyroid gland; atrophy of follicles, decrease in number of Hassall's corpuscles and the appearance of acidophilic cells. In the mouse injected with 3.0 $\mu c/g$ of ^{90}Sr on the 11th day of pregnancy, the whole thymus presented markedly enlarged capillary vessels with proliferation of basophilic cells and fatty degeneration was observed in the small lymph nodes. (NSA of Japan)

21291 BIOLOGICAL EFFECT OF ELECTRON BEAM IRRADIATION ON SMALL CREATURES. 3. CHANGE IN THE GENERATIVE ORGAN OF NEWTS DUE TO 60 MeV ELECTRON BEAM. Yamamoto, Masahiko; Motomura, Isao (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 143-7(Jun 1969). (In Japanese).

Electron beams of 60 MeV and 0.5 μ Coulomb, controlled by using a water tank, were used for irradiation of newts and changes of the genital glands were observed. Seminal glands and ovaries were extracted from the newts irradiated by electron beams and fixed with Bouin solution. Sliced with 10 μ width of paraffin and dyed with Azan, they were observed through a microscope. Results were as follows: in the cell forming spermatozoa, the abnormal condensation of genonema, the fusion, the severance, and the abnormal distribution of chromosomes, and the collapse of cells were observed. Cells suffering from superacute radiation death showed similar effects. In the cell forming ova, the change just after irradiation was slight, but several days after irradiation, abnormalities in the cytoplasm of young and mature cells, a decrease of nucleolus and the vacuole-like structure in the nucleus appeared. These facts show that the first action of electron beams is responsible for dividing cells. (NSA of Japan)

21292 HISTOLOGICAL CHANGES IN THE THYROID GLAND BY INJECTION OF RADIOACTIVE RAINWATER TO MICE IN PREGNANCY. Tanaka, Tetsuya; Muto, Tatsukichi (Mie Prefectural Univ., Tsu, Japan). Mie Med. J.; 18: 279-83(Jan 1969).

The histocytological changes in the thyroid gland induced by radioactive rainwater given in subcutaneous injection to 15 pregnant mice on the 8th day of pregnancy were studied. The results indicated: changes in the follicles were similar to those following ^{45}Ca injection; larger follicles were observed mostly in the circumferential area and the smaller ones in the central area; epithelial cells also presented changes similar to those induced by ^{45}Ca, but neither lack of epithelial cells observed in case of various radioisotopes nor generation of cilia on the epithelial cells caused by ^{90}Sr and ^{32}P were observed; colloid was found more in the follicles in the circumferential area than in the central area as in the case of ^{45}Ca; not many new follicles were produced either with radioisotopes or radioactive rainwater; distribution of capillary blood vessels was not as distinctive as in the case of ^{32}P. A small amount of radioactive rainwater proved to induce microscopically detectable histological changes in the thyroid gland. (NSA of Japan)

21293 RADIATION DEATH DUE TO CENTRAL NERVOUS SYSTEM INJURY. Sakka, Masatoshi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 148-9(Dec 1968). (In Japanese).

DD-strain and C57Bl-strain mice, Donryu-strain rats, guinea pigs, hamsters, rabbits, and mongrel dogs were irradiated with electron beams of 60 MeV. The integral electric current of 300 microcoulomb for 100 seconds was performed with Lineac, and central nervous system death due to radiation was studied. The results obtained were as follows: all animals studied died within 100 seconds showing neurological symptoms, their behavior up to death was recorded on films. In case of central nervous system death, mice were excited, whirled, and then died suddenly. All other animals did not show any excitation. The time from beginning of irradiation to death was almost the same in all animals studied. All animals seem to have a similar radiosensitivity to radiation induced instant death. Both whole-body irradiation and head-irradiation showed the same effect with respect to lethality. Wide beam irradiation, excluding the head, also was lethal, but it took several hours for the animals to die. Several tens of microcoulomb was sufficient for causing instant death in this type of irradiation and the time of death decreased corresponding to the increase of radiation intensity. Following irradiation with 900 microcoulomb for 100 seconds, rabbits died within several seconds. (NSA of Japan)

21294 BIOLOGICAL ACTION OF RADIOACTIVE PHOSPHORUS, ^{32}P IN MICE. Holmberg, E. A. D.; Pasqualini, C. Dosne; Rabasa, S. L. (Academia Nacionale de Medicine, Buenos Aires). Medicina (Buenos Aires); 28: Suppl. 1, 152-60(Dec 1968). (In Spanish).

Two different aspects of the biological effect of ^{32}P β particles were studied in inbred BALB mice, including the leukemogenic effect and effect on gonads. Phosphorus-32 was administered to adult mice in 10 doses which varied from 0.65 to 120 μCi. The overall incidence of leukemia was 27% in 351 animals, which represents a significant increase when compared to the 15% spontaneous incidence. The latency period was the same for both groups, with an average of 18 months. When the animals were separated according to sex, it was found that only females presented a significant increase in leukemia of 37% as compared to 16% in males. The effect of ^{32}P during fetal life was studied after its administration to the pregnant female, between the 11th and 15th day of gestation. The incidence of leukemia in the offspring was 46% in females with an average latency of 18 months. The males showed no difference from the controls. The administration of ^{32}P to adult BALB mice produces sterility only in the female. The threshold sterilizing dose of 40 μCi was raised to 90 μCi in pregnant females or after treatment with progesterone. The administration of ^{32}P to pregnant females during the 11th to 15th day of gestation, induced sterility in the offspring, male as well as female, with the same threshold dose of 40 μCi. The gonadal lesions are described. The effect of ^{32}P on the hypothalamic-hypophyseal axis was studied by means of in situ ovarian grafts and determination of the compensatory hypertrophy of the graft one month later. It was concluded that ^{32}P, in addition to its destructive effect on the gonads, produces a primary lesion in the hypothalamic-hypophyseal axis which results in a deficient formation of gonadotrophins, probably of the follicle-stimulating hormone. (C.H.)

21295 EFFECTS OF DIFFERENT SCHEDULES OF DOSE FRACTIONATION ON THE OXYGENATION STATUS OF A TRANSPLANTABLE MOUSE SARCOMA. Kallman, R. F.; Jardine, L. J.; Johnson, C. W. (Stanford Univ., Calif.). J. Nat. Cancer Inst.; 44: 369-77(Feb 1970).

As a follow-up on the earlier finding that sarcoma KHT in C3H/Km mice contained, on the average, 14 to 16% anoxic cells, and that the anoxic fraction was not altered significantly three days after five daily fractional doses of 190 rads of x radiation, the same tumor line was subjected to additional fractionation schedules to determine their relative effects on the anoxic fraction. The same conditioning dose, 950 rads, was administered as 2 × 475 rads, 3 × 317 rads, or as a single dose. Following conditioning irradiation, representative tumors were irradiated in situ with 950 to 2850 rads either in nitrogen-asphyxiated or in living, air-breathing mice. After final irradiation, the tumors were removed from the mice, their cells were suspended, and survival was determined by an endpoint-dilution method. The terminal slopes of

the pairs of dose-survival curves obtained for cells irradiated in killed and living mice were approximately parallel. Anoxic fractions were computed for tumors irradiated after the different fractionation regimens. This ratio was equivalent to the anoxic fraction if one assumed that the dose-survival curves for high test doses (≥950 rads) were parallel for tumors irradiated under anoxic conditions (in dead mice) and under different degrees of oxygenation (in living, air-breathing mice). Thus the latter curve was displaced according to the proportion of sensitive (adequately oxygenated) and resistant (severely hypoxic) cells when the tumors were irradiated; the TD50 was used as the quantitative criterion of cell survival. Except for 2 × 475 rads given 48 hours apart, the anoxic fractions for all other conditioning regimes did not differ significantly from those of unirradiated tumors. The regimen of 2 × 475 rads/48 hours produced a significantly lower mean anoxic fraction of 5.0%. Contrasted with other schedules, this particular regimen of conditioning irradiation resulted in a tumor that was better oxygenated. (C.H.)

21296 PARABIOSIS OF CBA PARENTAL AND (CBA-T6T6 x C57BL)F_1 MICE. Jurin, M.; Allegretti, N. (Ruder Boskovic Inst., Zagreb. Univ. of Zagreb). J. Nat. Cancer Inst.; 44: 237-55(Feb 1970).

The effect of altering the immunological reactivity of parental CBA mice before parabiosis with (CBA-T6T6 × C57BL)F_1 hybrids was investigated. In 90% of the pairs the hybrids died first when they were joined to untreated CBA mice, but in 10% both mice died. Hybrids dying of parabiotic disease showed a decreased body weight, transient anemia, a lowered peripheral mononuclear leukocyte count, reduced splenic weight and cellularity, an increased incidence of parental cells in mitosis in the spleen, and lymphoid tissue atrophy. CBA partners had transient polycythemia, a lowered peripheral mononuclear leukocyte count, an increased splenic weight and cellularity, and few hybrid cells in mitosis in the spleen. Over 70% of the midlethally x irradiated CBA parabionts died first when joined to F_1 hybrids, and showed signs of parabiotic (allogeneic) disease. The lethally irradiated CBA mice were protected from death by parabiosis with hybrids. Nonspecific presensitization of CBA mice with mycobacterium tuberculosis or specific sensitization by C57BL skin allograft caused earlier death of hybrid parabionts. Both specifically presensitized and midlethally irradiated CBA parabionts had marked lymphoid atrophy. Pink-stained material resembling amyloid surrounded atrophic lymphatic follicles. (auth)

21297 RADIOSENSITIVITY OF PRIMORDIAL OOCYTES IN THE RAT AND MONKEY. Beaumont, Heather M. (Univ. of Birmingham, Eng.). pp 71-9 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

The rat and monkey are born with a finite stock of primary oocytes, which become organized as primordial follicles. In mature animals oocytes in primordial follicles constitute a large proportion (ca. 90%) of the total population of germ cells; the remainder are at various stages of follicular growth. Quantitative studies of the effects of acute x irradiation on the ovary have shown that there are marked differences between the two species in the radiosensitivity of primordial oocytes. Few primordial follicles remain in the mature rat 18 hours after exposure to 315 R. In contrast, a dose of 7000 R is required to eliminate all primordial oocytes from the monkey within 28 days of exposure. Oocytes in growing follicles show similar sensitivity and are destroyed by doses of 4000 to 5000 R. Differences in radiation response may be correlated with variations in nuclear structure, demonstrated by light and electron microscopy. Primordial oocytes in the rat pass from diplotene into a dictyate phase, when the chromosomes apparently become very diffuse, and form a reticular network; chromosomes in growing oocytes are most compact. Oocytes in the monkey retain the diplotene configuration through all stages of follicular development and their chromosomes seem to be of the lampbrush type. There is some evidence that the pattern of RNA synthesis differs in primordial oocytes in the two species, and may be correlated with nuclear morphology. Preliminary results obtained from a new series of experiments indicate that hormonal factors may be implicated in radiation response, and perhaps affect the time taken for damaged oocytes to be eliminated from the ovary. (auth)

21298 EFFECT OF LASER BEAMS ON THE EXPOSED CEREBRUM OF EXPERIMENTAL ANIMALS. Jaenisch, W.; Altrock, H.; Dietz, W. Zentralbl. Allgem. Pathol. Pathol. Anat.; 110: 458-64(1967). (In German).

In mice and rats, small sections of the skull were removed without damage to the dura mater. Through the opening, a ruby laser beam was aimed at the surface of the brain. The exposed area showed necrosis, hemorrhage, and edema either singly or in combination. Because of the high light absorption in brain tissues the lesions were superficially located. As causative factor heat was assumed. Adjacent to the direct lesion, brain tissue showed mild gliosis and moderate inflammatory infiltration. No functional disturbance of larger brain sections was observed. (H.B.G.)

21299 EFFECTS ON RENAL FUNCTION. X-RADIATION COMBINED WITH SYSTEMIC ACTINOMYCIN D. Concannon, Joseph P.; Summers, Roy E.; Cole, Christine; Weil, Carrol (Allegheny General Hospital, Pittsburgh). Amer. J. Roentgenol., Radium Ther., Nucl. Med.; 108: 141-8(Jan 1970).

Systemic actinomycin D given concomitantly with x radiation did not cause enhancement of radiation effects on renal function and renal morphology in dogs as late as 20 weeks after treatment. The lack of enhancement of radiation effects on the kidney by actinomycin D is attributed to the extremely slow rate of cell renewal in the kidney. (auth)

21300 RECOVERY PROCESSES IN EMBRYONIC MICE EXPOSED TO FRACTIONATED X RADIATION. Konermann, Gerhard (Univ., Freiburg i. B.). Strahlentherapie; 139: 73-83(Jan 1970). (In German).

In order to examine the recovery mechanism of the embryo after fractionated daily x-irradiation, pregnant mice were irradiated at the 1st to 5th day p.c. (blastogenesis) and between the 6th and 13th day p.c. (fetogenesis) and compared to a control group that received a second series of irradiation during the fetal period. The fetuses are obtained at the 18th day by uterus section. From the percentage of normal, abnormal, and dead fetuses, and from the frequency of prenatal deaths and the weight of the fetus, it was deduced that there is not a pronounced radiosensitivity during the fetal period after irradiation during blastogenesis and an irradiation-free period during the organogenesis, within the dose range studied (10 and 80 R/day). After an irradiation during the organogenesis, there is an increased sensitivity of the fetus, as shown by the increased incidence in malformation and an increased mortality. (auth)

21301 RADIATION AND WOUND HEALING: EVOLUTION OF TENSILE STRENGTH IN EXCISED SKIN-WOUND OF IRRADIATED RATS. Stajic, Jovan; Milovanovic, Aleksandar (Inst. Boris Kidric of Nuclear Sciences, Belgrade). Strahlentherapie; 139: 87-90(Jan 1970).

The evolution of tensile strength gain in excised skin wounds of rats irradiated with 700 rad of whole-body gamma radiation was studied. The results showed that the wound tensile strength in irradiated animals becomes measurable 2 days later than in wounded controls. The dynamic of its increase was almost like the dynamic of gain of tensile strength in controls, but until the end of the observation period the strength level of controls was not reached. The difference was statistically significant up to the 14th postoperative day. Thereafter, it was significant with a tendency to decrease. Reasons for this finding were discussed. (auth)

21302 REACTIVITY OF THE HEMATIC SYSTEM IN RADIATION SICKNESS. Ul'yanov, M. I. pp 160-8 of Perelomy Kostey i Povrezhdeniya Sustavov Pri Luchevoy Bolezni. Moscow, Izdatel'stvo Meditsina (1967). (In Russian).

Results of hematologic studies in 255 rabbits are reported, 60 of which were subjected to closed or open infected trauma of the radius bone, 15 to radiation only (900 R), and 180 first to radiation and then to injury. Clinical observation lasted a month or longer, with particular attention to counts of leukocytes. Neutrophilic leukocytosis was soon observed in the injured animals; it developed slower and lasted longer in those with open infected fracture, decreasing after 4 to 10 days and reaching normal after a month. Hemoglobin and erythrocytes decreased, reaching minimum on the 7th to 10th day. Examination of the spinal punctate revealed a 2-fold increase in myelokaryocytes and an increased leuko-erythroblast ratio. Peripheral blood analysis and myelograms revealed a larger amount of young neutrophils and accelerated neutrophil production. A total of 135 of the animals subjected to trauma and x rays died at various times. Hematologic findings were much worse than those in animals subjected to trauma only, e.g., 50 to 80% less leukocytes and normalization only after 60 to 90 days. Erythrocytes decreased by 9 to 22%, myelokaryocytes by 70 to 90%, and the leuko-erythroblast ratio decreased sharply. Granulocytes and erythroblasts showed slow maturation, and mitoses in red blood decreased by ⅔. The spinal punctate showed degenerative changes. It was concluded that reactions to experimental trauma under radiation effect show pronounced differences. While leukocyte values hardly differed for animals exposed to closed trauma and radiation and those exposed to radiation only, those for animals with open trauma revealed a sharply increased reactivity to radiation. In the

former, the leukocyte number never fell below 4500 to 5000/cc, and they recovered after 30 days. These findings may be of interest to surgeons and other specialists. If radiation cannot be excluded and leukopenia follows trauma instead of neutrophilic leukocytosis, radiation sickness may be suspected. Further, if the reactivity of the hematic system is changed or depressed after radiation, hemostimulants may be ineffective or harmful, and only rest may be indicated. (JPRS)

21303 RADIATION INHIBITION OF PERITONEAL ADHESIONS: AN EXPERIMENTAL STUDY. Green, Nathan; French, Samuel; Fingerhut, Aaron (Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). Proc. Soc. Exp. Biol. Med.; 133: 544-50(Feb 1970).

The effect of total abdominal electron irradiation on the development of intraabdominal adhesions in the rat was investigated. Intraabdominal adhesions were induced by surgically stripping the serosa of the antimesenteric border of the ileum, or by intraperitoneal injection of colloidal silica dioxide. Total abdominal irradiation was given to one subgroup, 350 rads on day one. The second subgroup received 350 rads per day for three days. The third group was not irradiated and served as the control. Postoperative irradiation did diminish the amount of intestine adhesions; however, it did not prevent or enhance the extent of intestine adhesion. The parietal, liver, and intestine peritoneum responded differently to injury and irradiation. Adhesions rarely formed to the parietal peritoneum, frequently formed to the interlobar liver surface, and uniformly formed to the intestine. Liver capsule adhesions and skin union formed with the development of mature collagen that was strongly birefringent to polarized light. Intestine adhesions formed with amorphous basophilic collagen that was weakly birefringent to polarized light. Irradiation diminished the amount of adhesion scar to the intestine, but not to the liver or the parietal peritoneum. (auth)

21304 VARIATION OF RAT RADIOSENSITIVITY WITH INCREASED OXYGEN PARTIAL PRESSURE OF INSPIRED GAS. Zelac, R. E.; Cromroy, H. L. (Univ. of Florida, Gainesville). Health Phys.; 18: 227-31(Mar 1970).

It is generally believed that breathing gas with an oxygen partial pressure above that of air would increase the radiosensitivity of hypoxic cancerous tissues without increasing the radiosensitivity of normal tissues. The study described was undertaken to determine if this nonincrease in normal tissue sensitivity could be demonstrated. Female Holtzman strain albino rats, 50 days old, were irradiated with cobalt-60 γ radiation (100 cm SSD) to a midline muscle dose of 980 rads at a rate of 42 rads per min while breathing gas with oxygen partial pressure at or above 150 mm Hg. For the higher partial pressures, oxygen was added to the air present in a hyperbaric chamber to raise the total pressure to two or three atm absolute. Additional irradiations were made with added helium rather than oxygen. The measure of radiosensitivity employed was mean survival time (MST) following irradiation. A total of 100 animals was exposed. In three of four comparisons the MSTs of added oxygen groups were significantly less than those of the groups breathing air at atmospheric pressure, while in four comparisons the MSTs of added helium groups were not significantly different from the air groups, whose average MST was 10.3 days. These data from rats suggest an increased radiosensitivity of normal mammalian tissue in animals breathing oxygen-rich atmospheres. (auth) (UK)

21305 RECOVERY OF PROLIFERATIVE CAPACITY OF AGAR COLONY-FORMING CELLS AND SPLEEN COLONY-FORMING CELLS FOLLOWING IONIZING RADIATION OR VINBLASTINE. Chen, Michael G.; Schooley, John C. (Univ. of California, Berkeley). J. Cell. Physiol.; 75: 89-96(Feb 1970).

The effects of sublethal γ radiation and the mitotic inhibitor, vinblastine sulphate, on the number of cells in mouse bone marrow capable upon transplantation of forming macroscopic colonies on the surface of the spleens of irradiated recipient mice (CFU) and on the number of cells capable of forming colonies in soft agar after cell culture (ACFU) were studied as a function of time after injury. The results show that ACFU are radiosensitive and vinblastine-sensitive cells, comparable in sensitivity to erythropoietin-sensitive cells. The temporal pattern of recovery following irradiation of ACFU, different from that for CFU, is compatible with the concept that these are two distinct but closely related stem cell populations. The relevance of these findings to models of hematopoiesis and to studies on the precursors of macrophages and monocytes in inflammatory exudates is discussed. (auth)

21306 US AIR FORCE PERMISSIBLE EXPOSURE LEVELS FOR LASER IRRADIATION. Carpenter, John A.; Lehmiller, David J.; Tredici, Thomas J. (Air Force School of Aerospace Medicine, Brooks Air Force Base, Tex.). Arch. Environ. Health; 20: 171-6(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

A biomedical research program was established at the U. S. Air Force School of Aerospace Medicine to determine permissible human exposure levels for laser irradiation. These levels were designed to meet established standards of accuracy and safety, and yet be realistic in relation to the continuance of technological progress. Ocular exposures to laser beams, focused to the smallest possible spot, were employed. The medical damage end point for retinal damage was an opthalmoscopically visible lesion on the retina within 1 hr. Monkeys were used for the experiments because of their comparable optical quality to human systems. Ruby (long-pulsed and Q-switched), neodymium (long-pulsed and Q-switched), and argon (continuous wave) lasers were compared in regards to the relation between total energy (microjoules) and retinal damage probability (a statistically derived distribution relating energy levels to observed damage). Assuming a one to one relation between retinal damage in monkeys and in man, extrapolations to human values were made. From these extrapolated values, safe human exposure levels were predicted for retinal damage. Similar safe exposure levels were established for corneal damage in man. Data for these extrapolations were obtained from ocular exposures to a CO_2 laser. Rabbits were used in these exposure studies. (E.R.B.)

21307 OCULAR DAMAGE THRESHOLDS FOR THE HELIUM–NEON LASER. Lappin, Paul W. (Air Force School of Aerospace Medicine, Brooks Air Force Base, Tex.). Arch. Environ. Health; 20: 177-83(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

Rhesus monkeys were exposed to ocular irradiation from a helium-neon continuous-wave gas laser in an exposure time range of 2 msec to 10 sec. Approximately 500 exposures were made to determine mean damage threshold levels in 70 eyes for the macula and an extramacula area between the optic disc and the macula. The macula had a lower damage threshold than the extramacula area, the ratio of thresholds decreasing as exposure time is increased. The macula-extramacula threshold ratio varied from about 2 : 1 at 5 msec to 1.3 : 1 at 1 sec. (auth)

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Refer also to abstracts 21083, 21093, 21102, 21103, 21115, 21156, 21182–21184, 21193, 21195, 21211, 21219, 21221, 21249, 21255, 21261, 21262, and 21264–21266.

21308 MYELOMA: UNUSUAL CAUSE OF EXOPHTHALMOS, AN ANGIOARCHITECTURAL STUDY. Rosenbaum, Arthur E.; Zingesser, Lawrence H.; Reiss, James H.; Schechter, Mannie M.; Sanders, C. Drew (Albert Einstein Coll. of Medicine, Bronx, N. Y. USPHS Hospital, Staten Island, N. Y.). Radiology; 94: 379-86(Feb 1970).

The solitary or multicentric myeloma is an uncommon cause of exophthalmos. The angioarchitectural features found in these cases include subtle, increased vascularity, a rather homogeneous tumor stain, possible minute tumor vessels, rapidity of circulation, and involvement of meningeal vessels. The stain may be intimately related to the abnormalities of bone. The recognition of this lesion requires further investigation to exclude systemic disease. Plasma cell myeloma resulting in exophthalmos may be treated by x irradiation to obviate surgery. (auth)

21309 IRRADIATION OF THE LIVER IN CHILDREN: REVIEW OF EXPERIENCE IN THE ACUTE AND CHRONIC PHASES, AND IN THE INTACT NORMAL AND PARTIALLY RESECTED. Tefft, M.; Mitus, A.; Das, L.; Vawter, G. F.; Filler, R. M. (Children's Hospital Medical Center, Boston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 365-85(Feb 1970).

Evaluation of 115 children who had received x irradiation to the liver revealed an increase in abnormality of the parameters studied when large volumes of liver were irradiated or when the liver was irradiated following resection. To some extent, this was dependent on dose, but abnormalities were observed at doses below 2,499 Rads and as low as 1,200 Rads. Possibly, this may be related to the increased sensitivity of the younger child who generally received these lower dosages. Although evaluation in the chronic phase showed no significant difference of abnormality of age as related to dose, there did appear to be a slight trend in the acute phase of irradiation to implicate sensitivity of children under one year of age. (auth)

21310 THE EFFECT OF RADIATION ON THE LUNG AND BRONCHIAL TREE. Boushy, S. F.; Helgason, Agust H.; North, Lucell B. (Veterans Administration Hospital, Houston, Tex.

Baylor Medical Coll., Houston, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 108: 284-92(Feb 1970).

Forty-two patients had radiotherapy to the lung for bronchogenic carcinoma. All had pulmonary function studies before therapy and 33 had repeat studies after therapy. In 25 of those who died, autopsy was permitted and the lungs were inflated and formalin fume fixed. Pathologic evidence of radiation injury in bronchi was present in 73% of the cases compared to 40% in lung parenchyma. Roentgenographically, changes secondary to radiation were noted in 29% of the cases. In general, these changes as well as the changes in pulmonary function were mild. (C.H.)

21311 ETIOPATHOGENESIS OF THYROID CANCER. Mouriz, J. Acta Oncol.; 7: 100-8(Jan-Jun 1968). (In Spanish).

The problem of thyroid cancer induced by radiation was reviewed. Administration of methylthiouracil to animals given 30 μCi of ^{131}I induced thyroid carcinoma. It was assumed that the carcinogenic action of the antithyroid drug was potentiated by the irradiation. Effects of internal irradiation from ^{131}I deposited in the thyroid gland were reviewed. In patients treated for cervical adenitis with doses of x radiation that ranged from 500 to 1500 R, there was a high incidence of thyroid tumors that appeared from 10 to 20 yr after irradiation. Incidence of radioinduced thyroid tumors has been shown to be directly proportional to the radiation dose administered. Problems associated with transferring results to humans of studies in experimental animals, where radiation has been shown to induce thyroid tumors, were discussed. These involved problems of time as well as frequency of induction of thyroid tumors by radiation. (BBB)

21312 SURFACE IRRADIATION OF EUSTACHIAN TUBE. Beck, Chlodwig (Univ., Freiburg i. B.). Arch. Otolaryngol.; 90: 406-9(Oct 1969).

Irradiation of the eustachian tube with ^{90}Sr applicator was described. The 25 mCi ^{90}Sr source produced a dosage of 900 R/min at the surface of the mucosa. The length of the applicator was 14.8 mm and all the β irradiation was absorbed in a depth of 7 mm. The irradiation doses depended upon the measurements of eustachian tube resistance. Patients with a chronically inflamed tube plus middle ear catarrh were always irradiated in relation to their resistance measured before treatment. To prevent irradiation injuries, doses ranged from 900 R, given in 60 sec, up to 1600 R, given in 110 sec. If poor function of the tube persisted in spite of irradiation therapy, a second treatment was given 4 weeks later. The β rays did not destroy lymphatic tissue but altered its reactions. The two side effects observed were a buzzing in the ear and/or a temporary loss of hearing. Mechanical injury of the tubal mucosa, the rhinopharynx, and the tubal orifice was avoided. Late deleterious effects have not been observed in 16 yr. In 85 patients observed for 3 to 29 yr after irradiation, no pathology was observed. Less injury can be expected from β rays than from γ rays. For this reason, the use of ^{60}Co in the epipharynx and the tube was not acceptable. This isotope did not have a beneficial result in the cartilaginous part of the tube without damaging the tissue surrounding the cartilage. (BBB)

21313 COARCTATION OF THE AORTA AND OTHER LATE SEQUELAE OF ADMINISTRATION OF THORIUM DIOXIDE (THOROTRAST). Thind, Gurdarshan S.; Harner, Richard N.; Kaseff, Leon (Univ. of Pennsylvania, Philadelphia). Circulation; 41: 115-22(Jan 1970).

Coarctation of the aorta secondary to a cervicomediastinal thorotrastoma developed in a 30-year-old man 25 years after carotid arteriography. Other local manifestations of the thorotrastoma included occlusion of the left common carotid artery and partial occlusion of the left vertebral and left subclavian arteries, bilateral recurrent laryngeal nerve paresis, periesophageal adhesions, and multiple traction diverticula of the esophagus. There was no evidence of hepatic neoplasm or malignant transformation of the thorotrastoma. The major risk for this patient in the future, even though small, would be the development of a malignant hepatic neoplasm. Surgery may be indicated if local symptoms, enlarging tumor mass, or signs of increasing aortic obstruction develop. (auth)

21314 THE EFFECT OF THE NERVOUS SYSTEM ON THE COURSE OF RADIATION REACTIONS AFTER THE USE OF SOFT X RAYS. Bachurzewski, Janusz; Pawlowski, Andrzej; Wasylyszyn, Jerzy (Academy of Medicine, Warsaw). Przegl. Dermatol.; 56: 179-84(1969). (In Polish).

The effect of the nervous system on the development and progression of the cutaneous erythematous response to x radiation was investigated in human subjects and rabbits. Soft (37-kV) x rays were used in patients to give local doses of 1000 R and slightly harder (45-kV) x rays in rabbits for doses of 2000 R. To evaluate the effect of the nervous system on the course of erythematous radiation reactions in humans, symmetrical sites on the forearms of patients with unilateral paralysis or after unilateral sympathectomy were irradiated. In 1 female patient the normal erythematous reaction occurred on the paralyzed extremity with a 2-week delay, but the further course of the reaction was the same as on the normal extremity. On the ears of denervated (spinally and autonomically) rabbits the reaction usually occurred earlier and was more intense. On the other hand, the denervated ears did not show late complications in the form of perforation of the auricular concha. It is suggested that the altered course of the reaction is due to a better blood supply to the denervated ear. (BBB)

21315 CONSIDERATIONS IN THE EVALUATION OF THE BIOLOGICAL EFFECTS OF EXPOSURE TO MICROWAVE RADIATION. Cleary, Stephen F. (Virginia Commonwealth Univ., Richmond). Amer. Ind. Hyg. Ass. J.; 31: 52-9(Jan-Feb 1970).

The increasing use of microwave (SHF) and ultra-high-frequency (UHF) radiation in industry and in the home suggests the need for a re-evaluation of the available information concerning the biological effects of such exposures. A review of the thermal (>10 mW/cm^2) and nonthermal effects of microwave and UHF exposure on organisms, organs, cells, bacteria, and biological molecules is presented, as well as the exposure limits that have been based on such data. It is suggested that the area of greatest uncertainty is the effects of nonthermal exposure on the central nervous system. Suggestions are made for additional research on the effects of nonthermal exposures at various levels of biological systems. (auth)

21316 THE TREATMENT OF BLADDER NEOPLASMS IN THE RADIOTHERAPEUTIC INSTITUTE IN ROTTERDAM, 1950-1967. van der Werf-Messing, B. (Rotterdamsch Radio-Therapeutisch Instituut, Rotterdam). Ned. Tijdschr. Geneesk.; 113: 926-30(24 May 1969). (In Dutch).

Complications occurring in the course of treating 1000 patients (647 with curative doses and 353 for palliation) with radiation for bladder cancer are reported. Both supervoltage and conventional x radiations, combined with Ra implantation, were used. When the results of radiotherapy for the period 1950 to 1967 were evaluated, for all stages, it was found that the results after Ra implantation were better than those achieved by external supervoltage irradiation. In the group treated with Ra the prognosis after preliminary irradiation was again significantly better in Stages T_{II} and T_{III}, mostly due to a decrease of the rate of metastases in Stages T_{II} and T_{III}, to a decrease of the incidence of local recurrences in Stage T_{III}, and to complete elimination of scar metastases. In Stage T_{IV}, and in the group of T_{III} carcinomas unsuitable for Ra implantation, administration of the cytostatic agent Trenimon during the period of external supervoltage irradiation gave no significant improvement of the 3-yr prognosis. All cases of carcinoma in Stages T_I and T_{II} that were not suitable for Ra implantation, and all cases of T_{III} neoplasia were treated since 1965 with preoperative irradiation and cystectomy, if there were no clinical contraindications. The complications occurring in the 431 patients treated with Ra totaled 34 (7.5%), and included seven who required plastic surgery, one case of pyelonephrosis, one of abcessed and perforated bladder, six requiring nephrectomy, seven with shrunken bladder requiring reimplantation of the ureter, three with shrunken bladder requiring cystectomy, and seven others with necrosis of the bladder requiring 6 months to 1 yr for healing. (BBB)

21317 EYE PROBLEM IN LASER SAFETY. Ham, William T. Jr.; Clarke, A. M.; Geeraets, Walter J.; Cleary, Stephen F.; Mueller, Harold A.; Williams, Ray C. (Medical Coll. of Virginia, Richmond). Arch. Environ. Health; 20: 156-60(Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

The primary hazard from laser radiation is exposure of the eye. Radiation levels, if kept below those damaging to the eye, will not harm other tissues and organs of the body. Eye damage can range from mild retinal burns, with little or no loss of visual acuity, to severe lesions with loss of central vision, and up to gross overexposure with total loss of the eye. Long-term exposure of the retina to wavelengths in the visible spectrum, at levels not far below the burn threshold, may cause irreversible effects and should be avoided. Long-term exposure of the eye to the near infrared wavelengths can result in opacification of the lens and should be avoided. Overexposure of the cornea to ultraviolet wavelengths produces a painful inflammation of the corneal epithelium. Overexposure to a Q-switched laser is especially dangerous and can result in loss of the eye. Retinal lesions from overexposure to laser beams are usually small because of the spatial coherency of most lasers. However, gross overexposure can result in massive lesions. Optical instrumentation, such as telescopes and binoculars, increases the intensity of radiation on the

retina by a large factor, and also enhances the hazard because of image magnification. For exposure times long enough to attain temperature equilibrium, image size on the retina is an important factor. For a given irradiance on the retina in watts per square centimeter, both the time to reach equilibrium and the maximum temperature attained are strong functions of image size, being much less for small spot sizes than for large ones. Enough data are available currently to establish tentative safety standards. While the military departments, several government agencies, a few states, and many industrial corporations have established their own safety standards, there is not always agreement as to what constitutes safe exposure levels. There is a need for the establishment of national standards to resolve some of these discrepancies. At the present time, lasers do not constitute an environmental health hazard to the general public in the sense that water and air pollution, noise, etc., do, yet there is no assurance that this may not be the case in the future. It should be emphasized that there are other optical sources beside lasers in the modern environment that constitute a hazard to the eye. Among such sources are the nuclear fireball, the sun, xenon lamps and searchlights, germicidal lamps, welding arcs, infrared lamps, and photoflash sources. (auth)

21318 THRESHOLDS OF LASER EYE HAZARDS. Vassiliadis, Arthur; Zweng, H. Christian; Peppers, Norman A.; Peabody, Robert R.; Honey, Richard C. (Stanford Research Inst., Menlo Park, Calif.). Arch. Environ. Health; 20: 161-70 (Feb 1970).

From 2nd International Laser Safety Conference and Workshops, Cincinnati, Ohio. See CONF-690333.

The eyes of rhesus monkeys and humans were exposed to long-pulsed ruby and neodymium, Q-switched ruby and neodymium, and helium-neon (He–Ne) lasers to determine retinal damage thresholds. Rabbit eyes were exposed to a carbon dioxide (CO_2) laser to determine corneal damage thresholds. The data were gathered simulating accidental field exposures. The experimental data show that the white human fundus is appreciably less sensitive to damage from laser radiation compared to the rhesus monkey fundus. In general, the human threshold data obtained are considerably higher than some of the recommended safe levels. Corneal damage levels caused by CO_2 laser radiation were reported. The data were shown to be consistent with a simple thermal model. (auth)

Radiation Effects on Plants

Refer also to abstracts 21071, 21072, 21107, 21108, 21112, 21114, 21118, 21119, 21125, 21126, 21136–21147, 21202, and 21203.

21319 (RLO–353-36) RELATIONSHIP OF RADIATION-INDUCED DAMAGE IN BARLEY SEEDS TO THE INHIBITION OF CERTAIN OXIDOREDUCTASES BY SODIUM AZIDE. Sideris, E. G.; Nilan, R. A.; Konzak, C. F. (Washington State Univ., Pullman, Dept. of Agronomy). [1969]. 15p. (SM–121/12). Dep. CFSTI.

The effects of sodium azide post-treatment on seedling height and number of chromosome aberrations during first mitotic division in shoot tips were studied using barley (Hordeum vulgare) seeds given 16 krad of ^{60}Co γ irradiation. Sodium azide exhibited an inhibitory effect on the growth of seedlings, particularly when the seeds were treated in acidic solutions. Chromosome aberrations were not detectable with sodium azide alone, but increased with treatment by both sodium azide and radiation over radiation alone. It was concluded that under acidic conditions, an interaction between the chemical and ionizing radiation treatment was present. The synergism between sodium azide and radiation and its association with a decreased catalase, peroxidase, and respiratory activity is in agreement with basic postulates of radiobiology. (C.O.)

21320 (RLO–353-39) INFLUENCE OF RADIATION ENERGY ON THE OXYGEN ENHANCEMENT RATIO IN IRRADIATED BARLEY SEEDS. Bottino, P. J.; Nilan, R. A.; Konzak, C. F. (Washington State Univ., Pullman, Dept. of Agronomy). 28 Oct 1969. 32p. Dep. CFSTI.

Barley seeds were brought to water contents of 2 to 14%. Irradiation was accomplished with either a ^{60}Co γ source that delivered a dose at 1.25 MeV energy or with an x-ray source that delivered energies of 50, 100, 150, or 300 kV, all at 10 mA. After irradiation, the seeds were hydrated immediately in either oxygen- or nitrogen-bubbled water at 0° C. Four experiments were designed to study the following: the interrelation of oxygen, radiation energy, and seed water content; the relation of oxygen enhancement ratio (OER) and radiation energy in terms of chromosome aberration frequencies; free radical production by each energy of radiation; and the effects of radiation energy on the postradiation oxygen effect. The OER decreased with increasing water content independent of the energy used. The number of dicentric bridges per cell and fragments per cell decreased from 1.25 MeV to 100 kV, then increased at 50 kV. Similar relations occurred for the per cent aberrations and the ratio of aberrant cells to normal cells. ESR signal amplitude decreased slightly from energies of 1.25 MeV to 150 kV, then showed a large increase from 150 to 50 kV, representing a quantitative increase in free radicals at this lower energy. At all energies there was a decrease in oxygen response with increasing storage time. It was concluded that the energy of sparsely ionizing radiation can have an important influence on dry systems, such as the seed. There appeared to be real and important differences between ^{60}Co γ rays and x rays, and between low and high energy levels of x rays. (C.O.)

21321 (RLO–353-42) A STUDY OF FACTORS GOVERNING PLANT RADIOSENSITIVITY. Annual Progress Report, November 1, 1968–October 31, 1969. Nilan, Robert A.; Konzak, C. F. (Washington State Univ., Pullman). 15 Nov 1969. Contract AT(45-1)-353. 9p. Dep. CFSTI.

Progress is reported for studies to identify and elucidate mechanisms by which biological (especially genetic and cytogenetic) damage is induced, prevented, and repaired in irradiated plant cells. The role of gibberellic acid and sodium azide in the development and/or prevention of the free radical-catalase-peroxidase-peroxide pathway was emphasized and preliminary work was done to determine the effects of radiation on DNA and the interrelation among DNA changes, mutations, and chromosome aberrations in plant cells. Understanding of the initial physico-chemical mechanisms involved in the different components of damage was furthered. The development of standardized methods for the automat storage and retrieval of information on induced mutants and other plant germ plasm stocks was continued. A list of publications during the report period is provided. (C.O.)

21322 RADIATION STUDIES ON MEIOTIC CELLS OF CHLAMYDOMONAS REINHARDI. Davies, D. R. (Wantage Research Lab., Berks, Eng.). pp 123-33 of Effects of Radiation on Meiotic Systems. Vienna; International Atomic Energy Agency (1968).

From IAEA Meeting on the Effects of Ionizing Radiation on Meiotic Systems, Vienna, Austria. See STI/PUB-173; CONF-670525.

The comparative uv and γ sensitivities of pre-meiotic and meiotic cells of Chlamydomonas reinhardi have been determined. The pattern of change in response to these two radiations is different. The cells show an enhanced sensitivity to low doses of gamma radiation at one stage immediately before meiotic prophase, and in late prophase-metaphase. With uv followed by photoreactivation (PR) there is a gradual increase in sensitivity as cells move from early interphase to prophase and show little change thereafter. Following dark reactivation the pattern is completely different; the earliest stages of interphase are fairly resistant (DMF for PR 4.3), whereas later stages and early prophase are highly sensitive, and PR is not dose-modifying. At the 50% survival level the photoreactivating factor is 23 for some stages. Later stages in prophase are more resistant. An unusual response to uv is obtained with some stages, in that a phenomenon akin to that of uv reactivation in bacteriophage occurs, and survival can increase with increasing dose. The significance of these observations is discussed. (auth)

21323 EFFECTS OF COMBINATIONS OF MUTAGENS ON MUTATION FREQUENCY IN BARLEY. Aastveit, K. (Inst. of Genetics and Plant Breeding, Vollebekk, Norway). pp 5-14 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Two mutagens acting in sequence may produce higher or lower mutation frequencies than the sum of single treatments. Since 196 combinations of mutagens have been tried in barley and Vicia faba The results of three different barley experiments are presented. The mutagens tested, singly and in combination, are γ rays, EMS, DES and neutrons. The combination γ rays + EMS gave less than additive frequencies of mutated M_1 plants for chlorophyll mutations. When estimated on a spike or 1000 M_2-plant basis, on the other hand, the same combination gave more than additive effects. The over-additivity was most pronounced when the mutation rates were estimated as mutants per 1000 M_2 plants. The combined treatments gave the highest segregation ratios of albina and viridi mutants. These ratios also increased significantly with increased doses of EMS. It is concluded that the over-additivity of γ rays an EMS may to some extent be a dose effect. All treatments with γ rays and EMS led to increased variation in heading date and straw length of M_2 families. Some specific effects seem to exist. Large differences in the mutation frequencies were found after treatment with γ rays, EMS, DES and neutrons. Significant differences were

also found in the mutation spectrum and in the segregation ratios. Neutrons gave the highest relative frequencies of albina mutants and the highest proportions of mutants within segregating families. The mutation frequencies after combinations other than γ rays + EMS varied considerably and definite conclusions as regards additivity cannot yet be drawn. (auth)

21324 DOSE-RATE EFFECTS IN SAINTPAULIA. Broertjes, C. (Inst. for Atomic Sciences in Agriculture, Wageningen, Netherlands). pp 63-71 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

Work on Saintpaulia ionantha, that is being used as a test plant for the study of dose-rate effects, is discussed in detail. (auth)

21325 NEUTRON-SEED-IRRADIATION PROGRAMME. Osborne, T. S. (Joint FAO/IAEA Div. of Atomic Energy in Food and Agriculture, Vienna). pp 281-2 of Mutations in Plant Breeding. II. Vienna; International Atomic Energy Agency (1968).

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria. See STI/PUB-182; CONF-670942.

A program is presented for the use of reactors as radiation sources in plant mutation experiments in various countries. The problems of dosimetry, cost, and standardization of techniques are discussed. (F.M.M.)

Radiation Effects on Microorganisms

Refer also to abstracts 21076, 21084, 21119, 21124, and 21208.

21326 RADIATION RESISTANCE IN BACTERIA. Matsuyama, Akira; Kitayama, Shigeru (Inst. of Physical and Chemical Research, Yamato, Japan). Seikagaku; 41: 699-713(Oct 1969). (In Japanese).

Radioresistance of bacteria is summarized. In target theory, DNA is regarded as a chief target within cell, but multiple targets other than DNA should be considered. The problem whether the change of radiosensitivity in cell cycles is related to double strand scission of DNA is discussed. Septum formation at the time of cell division is thought to be radioprotective and in some radioresistant bacteria a substance that promotes septum formation is found. In radioresistant bacteria, injured DNA seems to recover by a simple process, but any definite correlation between mutation of hereditary property and recovery system is not yet found. It is reported that a radioprotective substance exists in M. radiodurans which is highly radioresistant, but it is assumed that a very effective recovery system for DNA strand scission exists in it. The mechanism of radioresistance of spores and water distribution in spores is discussed with respect to the indirect effect of radiation on DNA. (NSA of Japan)

21327 STUDY OF THE VIRICIDAL EFFICIENCY OF UV RAYS IN EXPERIMENTAL DECONTAMINATION OF THE AIR SURFACES. Slobodenyuk, A. V.; Karpukhin, G. I. (Inst. of Virus Infections, Sverdlovsk, USSR). Gig. Sanit.; No. 12, 25-8 (Dec 1969). (In Russian).

The viricidal efficiency of shortwave uv rays for influenza virus, adenovirus and poliomyelitis virus was studied under experimental conditions. When the intensity of a radiation source amounted to 1 vt/m^3 the above-mentioned viruses in the aerosol state were inactivated in 25 to 30 min. On the horizontal surfaces situated at a distance of 2m from the lamp the adenovirus was inactivated by uv rays in 52 min and the poliomyelitis virus in 58 min. When the relative humidity of the air increased from 55 to 60 up to 90 to 95 percent, the exposure time necessary for inactivation of the adenovirus in the aerosol had to be increased 1.5 times. (auth)

21328 TOPOLOGICAL RELATIONSHIP OF PROPHAGE λ TO THE BACTERIAL CHROMOSOME IN LYSOGENIC CELLS. Freifelder, David; Meselson, Matthew (Brandeis Univ., Waltham, Mass. Harvard Univ., Cambridge, Mass.). Proc. Nat. Acad. Sci. U. S.; 65: 200-5(Jan 1970).

X irradiation converts bacterial sex factor DNA covalent circles to more slowly sedimenting forms according to first order kinetics. The rate of conversion is greater for sex factors carrying λ prophage than it is for nonlysogenized sex factors. The magnitude of the difference and the absence of covalent circular DNA from the product show that the prophage DNA is linearly inserted into the sex factor, as predicted by Campbell's model for lysogenization. (auth)

21329 PROTON RADIATION OF MICROORGANISMS MICROCOCCUS RADIODURANS AND SARCINA FLAVA PLACED IN A METEORITE. Vdovykin, G. P.; Abyzov, S. S.; Vdovykina, T. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow. Inst. of Microbiology, Moscow). Dokl. Akad. Nauk SSSR; 189: 192-5 (1 Nov 1969). (In Russian).

In order to determine whether microorganisms could survive intense proton bombardment, a mixture of the above organisms were placed in the center of a Migei meteorite which was 6 × 7 × 10 mm in size and weighed 0.4 g. The chrondritic meteorite and four other control samples of Armenian volcanic rock containing the same mixture of organisms were irradiated for 45 hr with 600 MeV protons on a synchrocyclotron. The estimated dose was 1×10^8 rads from the $^{27}Al(p,3pn)^{24}Na$ reaction on aluminum. Smaller doses of 2×10^4 to 5×10^4 rads were also used to estimate the survival of the microorganisms at lower doses. Before irradiation the number of Micrococcus radiodurans cells was 430×10^6, and the number of Sarcina flava cells was 297×10^6 per g of substance. No cells of either type could be detected either in the chrondrite or the volcanic rock after irradiation at a dose of 1×10^8 rads. A total of 2,000 Sarcina flava cells and no Micrococcus radiodurans cells were found at a dose of 2×10^4 rads. These results indicate that it is unlikely that microorganisms can survive the high radiation doses to be found in cosmic space. These conclusions are also in agreement with American data from Apollo-11 which showed an absence of microorganisms on the surface of the moon. (TTT)

21330 MUTANTS OF DIPLOCOCCUS PNEUMONIAE THAT LACK DEOXYRIBONUCLEASES AND OTHER ACTIVITIES POSSIBLY PERTINENT TO GENETIC TRANSFORMATION. Lacks, Sanford (Brookhaven National Lab., Upton, N. Y.). J. Bacteriol.; 101: 373-83(Feb 1970).

Mutants of Diplococcus pneumoniae that lacked the two major deoxyribonucleases of the cell —one an endonuclease, the other an exonuclease preferentially active on native deoxyribonucleic acid (DNA) —were obtained. The development of a method for detecting mutant colonies, based on the binding of methyl green to DNA, facilitated isolation of the mutants. Neither enzyme was essential for growth of the cells, for repair of uv damage, or for any phase of DNA-mediated transformation. Residual deoxyribonuclease activity in the double mutant corresponded to an exonuclease, approximately one-fifth as active as the major exonuclease, that attacked native and denatured DNA equally well. This activity appeared to be associated with the DNA-polymerase enzyme. A mutant that apparently lacked a cell wall lytic enzyme was also fully transformable. A mutant strain that was four times more sensitive to uv light than the wild type also transformed normally. Recipient cells of this strain were deficient in the repair of uv-irradiated transforming DNA. Mutants were found that, unlike the wild type, integrated donor markers only with high efficiency, thereby indicating that a particular cellular component that is susceptible to loss by mutation, such as an enzyme, is responsible for low integration efficiency. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 20832.

21331 (MIT-4049-2) TOXIN PRODUCTION BY NATURALLY OCCURRING LEVELS OF CLOSTRIDIUM BOTULINUM IN IRRADIATED AND NONIRRADIATED SEAFOOD. Final Report. Nickerson, J. T. R.; Goldblith, S. A. (Massachusetts Inst. of Tech., Cambridge). 1969. 24p. Dep. CFSTI.

A total of 150 samples (450 individual portions) of commercially produced cod and haddock fillets were incubated and tested for botulinum toxin. Each sample consisted of ground and mixed cod or haddock fillets packaged in polyethylene as three, 100 gram portions. One portion of each sample received no further treatment, one portion was irradiated with gamma rays at a dose level of 100 krad and one portion was irradiated with gamma rays at a dose level of 200 krad. All portions of all samples were incubated for 6 days at 70°F, then extracted with cold gel-phosphate buffer. The trypsinized and nontrypsinized extract were injected intraperitoneally into mice, protected and not protected with botulinum antitoxins (types A, B and E). All mice were treated with antibiotics prior to injection. The mice were observed over a period of 96 hours for symptoms of botulism and death. Among the 480 individual portions tested only one, a 200 krad treated portion, produced symptoms and death typical of botulism. This was not an E or B type but probably was type A botulism. Since it has been shown that, in neutral vegetable products, periods longer than 30 days at 50°F would be required for type A Clostridium botulinum to outgrow and produce toxin, there is doubt that any public health hazard exists in treating fish fillets with gamma rays at a level of 200 krad. None of the portions treated with gamma rays at 100 krad produced symptoms of botulism in mice when injected. The dose

rate of Mark 11 ^{60}Co source was determined. This was done in such a manner that the same mass was present in the irradiation chamber as when fish fillets were irradiated in portions of 20 pounds (two 10 pound containers) and as the 100 gram portions were irradiated for the experiments reported herein. (auth)

21332 (WASH-1131) BENEFIT-COST ANALYSIS OF LOW-DOSE RADIATION PROCESSED FOODS. PUBLIC BENEFIT-COST AND DISCOUNTED NET CASH FLOW COMMERCIALIZATION. POTENTIAL ANALYSES TO SELECT PRODUCTS FOR TECHNOLOGY DEVELOPMENT. Claflin, Alan B. (Atomic Energy Commission, Washington, D. C.). Jun 1969. 120p. Dep. CFSTI.

The completion of the selection of food products to undergo technology development under the AEC's program for radiation preservation of foods is reported. After screening by a market structure test (food products for which radiation pasteurization appeared to be technically feasible and having a recognized spoilage loss problem and adequate product value and volume), products were further screened by estimating the commercialization potential of the irradiated product. Oranges, chicken, and West Coast sole were not commercially feasible; strawberries, mushrooms, shrimp, and blue crab were feasible. Among those chosen as commercially feasible, the benefit-cost ratio ranking was in the following order: shrimp, strawberries, mushrooms, and blue crab. Blue crab was eliminated because of total program resource limitations, product mix considerations, and the state of alternative technologies. The complete product selection list is as follows: East Coast finfish (cod and haddock); tropical fruit (mango and papaya); strawberries; mushrooms; and shrimp. (C.O.)

21333 IRRADIATION WITH CO_2 UNDER PRESSURE. Urbain, Walter M.; Shank, Joseph L.; Kauffman, Floyd L. (to Swift and Co.). U. S. Patent 3,483,005. 9 Dec 1969. Filed 31 Oct 1966.

Effects of high-energy ionizing radiation on organoleptic properties of food products are discussed. These effects are compared with the effects of low-energy ionizing radiation administered under pressurized carbon dioxide. (H.L.W.)

21334 INHIBITION OF GERMINATION OF POTATO BY IRRADIATION. Umeda, Keiji (Food Research Inst., Tokyo). Nyu Fudo Indasutori; 11: No. 12, 27-32(Dec 1969). (In Japanese).

Production of potatoes in Japan has exceeded 4 million tons a year, which is the largest output in our agricultural products except rice. Potatoes harvested from April to June are sent directly to the market, while those harvested from July to October are stored. As for the storing methods, refrigeration is effective but presents economic problems and the use of chemicals is not reliable. Irradiation treatment with cobalt-60 γ rays is studied. Seven Krad and 15 Krad are used for irradiation of potatoes on every 15th, 43rd and 45th day after the harvest according to species and results of controlling the germination and the decrease in weigh were investigated. Summaries of the test are given. For the practical control of the germination, when the storage period is set for 8 months following harvest, 7–15 Krad irradiation gives sufficient results if it is applied during sleeping period or within the germination of about 0.5–1.0 cm. The test on the quality of irradiated potatoes shows that the irradiated potatoes are better for tasting without processing while nonirradiated potatoes are better for potato chips, etc. The potatoes stored at room temperature kept better quality both in irradiated and nonirradiated potatoes. As a result, potatoes used both for food and for processing, the most effective way from the aspects of quality and cost is to irradiate with 7–15 Krad before germination and to store them at room temperature. (NSA of Japan)

21335 PRESERVATION OF AVOCADO PEARS BY GAMMA IRRADIATION. Eisenberg, E. (Soreq Nuclear Research Centre, Yavne, Israel); Foa, E.; Monselise, J. J. Israel J. Technol.; 7: 415-17(1969).

Attempts to prepare a stable avocado paste by heat treatment have so far not been successful owing to the objectionable bitter taste present in the product. Some experiments were performed to explore the possibility of obtaining a stable and more palatable avocado paste by use of γ radiation. The results of preliminary experiments using radiation doses in the range 0.5 to 4.5 Mrad are reported. The influence of different variables on stability and taste were studied, specifically the presence or absence of air, treatment at low temperatures, pH, and additives such as K-sorbate, NaCl, and antioxidants. In no instance was the characteristic bitter taste of the heat-treated avocado paste detected in the irradiated product. The irradiated paste, was, however, rated poor as regards general taste, color and flavor. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 22023.

21336 (AI-AEC-12913) FUELS, MATERIALS, AND COOLANT CHEMISTRY PROGRAMS. Quarterly Technical Progress Report, October–December 1969. (Atomics International, Canoga Park, Calif.). 15 Feb 1970. Contract AT(04-3)-701. 84p. Dep. CFSTI.

Progress is reported on research and development in materials management, radiation effects on reactor materials, determination of radioinduced helium distribution and effects in reactor materials, characterization of mixed carbide fuels, solvent properties of sodium for reactor materials, and distribution of radioisotopes between liquid sodium and containment materials. (J.R.D.)

21337 (BMI-1878) PROGRESS ON DEVELOPMENT OF MATERIALS AND TECHNOLOGY FOR ADVANCED REACTORS DURING OCTOBER–DECEMBER 1969. Quarterly Report, Tasks 6, 7, and 14. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Jan 1970. Contract W-7405-eng-92. 85p. Dep. CFSTI.

Research and development progress is reported in three sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 21396, 21409, and 21443.

21338 (SRO-475-5) POWDER METALLURGY COMPACTION. Quarterly Progress Report, December 1, 1969–February 28, 1970. Schwartz, E. G.; Wilson, Kenneth L.; Hornsby, James B. (South Carolina Univ., Columbia. Coll. of Engineering). Contract AT(38-1)-475. 18p. Dep. CFSTI.

Activities in programs to establish a lubricant spraying system and to investigate the effects of axial die movement during powder compaction are reported. Details of work on die lubrication are given along with results of studies on die movements. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 20936.

21339 (BM-RI-7371) REACTION OF Co–Ni–V ALLOYS WITH O_2 AT 1,351° TO 1,429°K. Doerr, Robert M.; Jensen, J. W. (Bureau of Mines, Rolla, Mo. Rolla Metallurgy Research Center). Apr 1970. 20p.

Results of research on the effects of vanadium alloy additions on the oxidation behavior of cobalt-nickel alloys are summarized. Eighteen alloys were reacted with O_2 at 0.5 atm and 1351, 1389, and 1429°K. The alloy compositions consisted of Co–Ni master alloys (0, 22, 50, 70, 91, and 100 wt % Ni) with V additions of 0, 0.9, and 2.7 wt %. Large early deviations from, or changes in, the parabolic rate constant were encountered, but the reaction rate in most cases declined approximately in accordance with the parabolic rate law. Relatively, the vanadium degraded the oxidation resistance most at the highest nickel contents. In some cases, melting of the oxide was inferred from microscopic evidence and x-ray diffraction measurements disclosed the presence of low-melting vanadates. (auth)

21340 (ORNL-TM-2827) OXIDATION OF VANADIUM AND VANADIUM ALLOYS IN SODIUM. Klueh, R. L.; DeVan, J. H. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 24p. Dep. CFSTI.

Vanadium-base alloys are potential fuel cladding materials for sodium-cooled fast breeder reactors. The mechanical and corrosion properties of vanadium alloys in sodium are strongly affected by oxygen impurities in the sodium. Vanadium and vanadium alloys readily absorb oxygen from liquid sodium at 500 to 600°C when the sodium contains as little as 1 ppM of oxygen, the kinetics depending upon the composition of the alloy. Alloys containing titanium and aluminum absorb oxygen with the simultaneous formation of a subsurface hardened zone. The depth of this zone depends on time, temperature, the oxygen content of the sodium, and the composition of the alloy. Pure vanadium or vanadium containing chromium or niobium absorbs oxygen somewhat faster and without the formation of a pronounced hardened zone. The published corrosion results for vanadium-titanium and vanadium-aluminum in terms of internal oxidation were examined. In this process oxygen dissolves in the alloy and reacts with the dissolved titanium or aluminum to form TiO_2 or Al_2O_3, which precipitates. This precipitate gives rise to the hardened zone. It has been shown that the kinetics of hardened zone formation obeys the internal oxidation model proposed by Wagner when no vanadium oxide scale forms on the external surface and obeys the model proposed by Rapp and Colson when an external scale forms. Discussions are included on how internal oxidation theory and alloy oxidation theory (noninternal oxidation) can be used in the development of alloys for sodium applications. (auth)

21341 (TRG-Report-1966) DEVELOPMENT AND PERFORMANCE OF ZIRCALOY-2 PRESSURE TUBES. Watkins, B. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). Mar 1970. 22p. (CONF-691115-5). Dep. CFSTI (U. S. Sales Only).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia.

The prototype SGHWR incorporates Zr-2 pressure tubes 5.14 in. diam., 0.2 in. thick and 15 ft. long to a straightness tolerance of 1/3000. The development work and the assessment of the mechanical and corrosion behavior of the pressure tubes are described. The pressure tubes absorb hydrogen from the corrosion reaction and this leads to reduced ductility. This embrittlement is assessed in terms of critical crack length and this is related to the operational conditions. It is shown that under the most onerous service condition the through-thickness defect, where instability occurs, is of the order of 4 in. Leakage rather than catastrophic failure can be expected to occur at a through-thickness defect of about ½ in. Irradiation enhances the creep rate of Zircaloy-2 and this has necessitated extensive in and out of reactor testing. A design philosophy based on a strain criterion to failure is developed and it is demonstrated that the anticipated creep strains do not lead to operation restriction and give a big margin of safety on both the stress and time to tube rupture. Surveillance techniques were developed to monitor embrittlement by means of fracture mechanic techniques and to measure creep deformation by bore measuring techniques. The results are discussed in relation to the earlier prediction and reactor performance. (auth)

21342 GASEOUS DIFFUSION CONTROL OF THE REACTION BETWEEN URANIUM AND CARBON DIOXIDE AT HIGH TEMPERATURES. Pearce, R. J. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 34: 332-6 (Mar 1970).

Gaseous diffusion control is proposed as the mechanism for the high-temperature oxidation of uranium in carbon dioxide. Extremely good agreement was found between cited experimental data and theory. (G.M.C.)

Preparation and Fabrication

Refer also to abstracts 21377 and 21381.

21343 (BNWL-1288) DOWNWARD VACUUM VAPOR DEPOSITION OF RARE EARTHS ONTO HOLLOW MICROSPHERES. Coleman, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 23p. Dep. CFSTI.

Development of a method to contain polonium for isotopic heat source application, involved a process for deposition of a 6 μ uniform rare earth coating onto 0.006-in.-diameter spheres. Procedures developed to deposit uniform rare earth coatings using vacuum vapor techniques are described. Information and discussion are included on developing techniques to evaporate and monitor thick rare earth coatings, obtain proper sphere movement for uniform coatings, prevent oxidation of the rare earth film, and determine routine coating procedures. (auth)

21344 (NP-18096) ON THE MELT ELECTROLYSIS OF NIOBIUM. Schenk, Ganda (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1968. 144p. (In German). (DISS-4235). Dep. CFSTI (U. S. Sales Only).

Thesis.

Niobium was obtained from $NbCl_5$ melts with 1.5 to 10% F and 0.1 to 6.5% Nb at current densities of 0.3 to 3 amp/cm² and temperatures of 650 to 880°C. The best conditions were 2 to 2.5% Nb, 8% F, j_K = 1 amp/cm², and T = 760°C. The current yield was then 77% and the impurities were 410 ppM H, 370 ppM 0, 96 ppM N, 493 ppM C, and the sum of the metallic impurities was below 220 ppM. From K_2NbF_7 melts Nb was separated at F contents between 5.9 and 18.7% and Nb contents between 2 and 5% at current densities of 1 amp/cm² and temperatures from 650 to 760°C. The best conditions were 2.8% Nb, 9.4% F, j_K = 1 amp/cm², and T =

760°C. The current yield is about 87%. The impurities were 195 ppM Cl and the sum of the metallic impurities was less than 1544 ppM. In the same melts Nb was refined. The conditions varied between 2.8 to 4.3% Nb, 10 to 12.9% F, 0.1 to 3 amp/cm^2 cathode current density for larger or smaller refining cells. The largest cell gave the best results. The best conditions were 4% Nb, 12.9% F, 0.1 amp/cm^2 current density, and 790°C melt temperature. A Nb with 1.35% C and 3092 ppM metallic impurities could be refined to 122 ppM C and less than 1178 ppM metallic impurities and one with 330 ppM C and 1182 ppM metallic impurities to 60 ppM C and 495 ppM metallic impurities. (tr-auth)

21345 (RMI-14) SEMIANNUAL PROGRESS SUMMARY [ON FUEL ELEMENT FABRICATION], JULY–DECEMBER 1969. (Reactive Metals, Inc., Ashtabula, Ohio). 10 Feb 1970. Contract AT(30-1)-1405. 34p. Dep. CFSTI.

Use of a straight mandrel has been chosen as the best potential route for extrusion of I and E fuel elements. A mandrel design and material have been selected and experiments have determined optimum extrusion parameters. No conclusions as to possible dimensional control have been drawn. A shrink fit die and holder assembly has been used on production extrusions. Some difficulty has been experienced with die closure, although an improvement in ovality was obtained. Additional extrusion lubricants were tested on the laboratory extrusion press. One commercial lubricant (Shell's 78226) does show some potential of improving the extrusion surfaces. Testing will be continued. When it became apparent during late FY 1969 that there were end problems with NPR Outer Mark VI extrusions, investigations were begun which led to certain procedure and tooling changes which are helping to eliminate the problems. Work has been performed on tests at increased ram speed and increased billet temperature; tests at increased ram speed only (ram speeds up to 65 in./min.); tests with drop quenching; and tests at the reduced overstock level of 0.055" OD and 0.030" ID. A production scale test of the precision extrusion process produced poor yields due to difficulty in die-sizing. Tooling size changes are being made because of the change to induction heat treatment at NLO. A group of special alloy Uranium 4 wt.% niobium billets was extruded on the 360 ton laboratory press for the Dow Chemical Company. These billets were gamma extruded with no difficulty. (auth)

21346 (SC-B-68-298) PRODUCTION OF METAL POWDERS BY ATOMIZATION FROM THE MELT. A SELECTIVE BIBLIOGRAPHY. Patrick, Carolyn (comp.) (Sandia Labs., Albuquerque, N. Mex.). Jul 1968. 12p. Dep. CFSTI.

A selective bibliography, with abstracts, on the production of metal powders by atomization from the melt is presented. The period October, 1949, through July, 1968, is covered. (auth)

21347 (TUBIK-13) COMPILATION OF PHYSICAL DATA FOR THE LIQUID METALS Li, Na, K, Rb, Cs. Freund, Juergen (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). Jul 1969. 184p. (In German). Dep. CFSTI (U. S. Sales Only).

A compilation of physical data which contains nuclear engineering data and the thermophysical properties of the liquid and vaporous phases of the alkali metals Li, Na, K, Rb, and Cs is presented. The temperature-dependent physical data are represented in diagrams. For each property, the results of various investigators are given to permit comparisons. In addition to the diagrams, the equations proposed for the equalization curves are compiled. Critical data and solubility curves for oxygen and hydrogen are included. (tr-auth)

21348 TANTALUM. Emerson, Mark E. Eng. Mining J.; 171: No. 3, 117-19(Mar 1970).

Factors affecting supply and demand of Ta are reviewed. Information is included on markets, sources, production, and stocks. (J.R.D.)

21349 COLUMBIUM. Buttner, F. H. (Battelle Memorial Inst., Columbus, Ohio). Eng. Mining J.; 171: No. 3, 130-3 (Mar 1970).

Factors affecting supply and demand of Nb are reviewed. Information is included on Nb production, Nb consumption, and production outlook. (J.R.D.)

21350 BERYLLIUM. Schilling, S. A. Eng. Mining J.; 171: No. 3, 116-17(Mar 1970).

The status of production and consumption of Be is reviewed. Comment and discussions are included on production, usage, prices, and sales outlook. (J.R.D.)

21351 THORIUM. Stevens, Richard F. Jr. Eng. Mining J.; 171: No. 3, 113-15(Mar 1970).

The status of Th production and consumption of Th is reviewed. Comment and discussion are included on legislation and government programs, mine production, refinery production, uses, imports, exports, nuclear developments, and outlook. (J.R.D.)

21352 URANIUM. Sherman, John T. (Atomic Industrial Forum, Inc., New York). Eng. Mining J.; 171: No. 3, 92-6(Mar 1970).

Factors affecting sales and production of U are reviewed. Comment is included on nuclear power plant sales, U requirements, U. S. reserves, exploration, Government actions, radiation exposure in mines, public opinion, domestic industry news, and developments in other countries. (J.R.D.)

21353 RARE EARTHS. Cannon, Joseph G. (Molybdenum Corp. of America, New York). Eng. Mining J.; 171: No. 3, 90-2 (Mar 1970).

A review of information on supply, uses, demand, production, sources, and consumers of rare earths is presented. (J.R.D.)

21354 CADMIUM. Baker, Crosby (American Smelting and Refining Co., Inc., South Plainfield, N. J.). Eng. Mining J.; 171: No. 3, 89-90(Mar 1970).

Production and consumption of Cd are discussed. Data on production and uses during 1967 through 1969 are tabulated. A forecast of Cd production and consumption is included. (J.R.D.)

21355 ZIRCONIUM–HAFNIUM. Couch, G. Robert (American Metal Climax, Inc., New York). Eng. Mining J.; 171: No. 3, 87-9(Mar 1970).

It is noted that at the present and for the near-term future Zr and Hf metal markets are tied to the nuclear power market. Information and discussion are included on production outlook for these metals, along with comment on supply, fabrication, price and market developments. (J.R.D.)

21356 PREPARATION AND MECHANICAL PROPERTIES OF Ti–W ALLOYS PREPARED BY REDUCTION OF CHLORIDES. Moinov, S. G.; Reznichenko, V. A.; Solonina, O. P.; Ulyakova, N. M.; Egorov, S. I. Izv. Akad. Nauk SSSR, Metal.; No. 1, 26-32(Jan-Feb 1970). (In Russian).

The preparation of Ti–W alloys and the possibility of its application for obtaining a homogeneous composition of the alloy are discussed. An increase in tungsten content by 10% increased the range of strength of titanium, but reduced plasticity during forging. The effects of thermal treatment on hardening at room temperature were significant. A noticeable loss in strength for Ti–W was noted at 300 to 550°C. In alloys with 6 and 10 % W, above 400°C, the normal change of magnitudes of the transverse contraction was observed which indicates increased creep resistance. (auth) (TSS)

21357 MONOKRISTALLY TUGOPLAVKIKH I REDKIKH METALLOV. (Monocrystals of Refractory and Rare Metals). Savitskii, E. M. (ed.). Moscow; Izdatel'stvo Nauka (1969). 192p.

Thirty-four articles are included on studies of structure, properties, and applications of refractory and rare metals. The methods for preparing large monocrystals of molybdenum, tungsten, and vanadium are discussed. Metallographic analyses were made of the structure and properties of monocrystals of Mo, Va, W, Nb, La, and Y and their physical and mechanical properties were determined at various temperatures and pressures. The behavior of these metals in plasmas, in electrovacuum devices, and as cold cathodes was also analyzed. (R.V.J.)

21358 A CONTRIBUTION TO THE STUDY OF MOLYBDENUM POWDER SINTERING. Uskokovic, D.; Zivanovic, B.; Ristic, M. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 12.1-15 of Recent Material Developments in Powder Metallurgy. Vol. I. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943-(Vol.1).

The kinetics of the sintering of molybdenum powders was observed on a dilatometer, by automatic registration of sample shrinkage and its temperature. The samples had been pressed in a steel die on a hydraulic press. Sintering was carried out in an argon atmosphere under constant gas pressure. Dilatometric analysis of the kinetics of isothermal sintering was made at 1230, 1280, 1350, 1405, and 1460°C. An equation was formulated to determine the kinetics of isothermal sintering of the powder at 1280 to 1460°C. Value for the experimental activation energy obtained in the tests were compared with literature data. (J.C.W.)

21359 DISPERSION HARDENED CONTACT MATERIALS ON THE BASIS OF SILVER. Schreiner, H. (Siemens AG, Huremberg). pp 18.1-13 of Recent Material Developments in Powder Metallurgy. Vol. I. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). (In German).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943-(Vol.1).

Methods for producing dispersion-hardened silver-base contact materials are described. Ag–CdO is described in detail. The three methods include: production by internal oxidation of the fusible silver alloys; production of powder composition of silver and metal oxide; and production of compound powder of silver and metal oxide. In addition to the CdO content, the properties of these contact materials are determined by the type of structure. The change of the structure in the surface layer during working is described. (auth)

21360 STUDIES OF PRODUCTION CONDITIONS AND PROPERTIES OF NICKEL AND COPPER REINFORCED BY TUNGSTEN FIBERS. Karpinos, D. M.; Tuchinskiiy, L. I. pp 23.1-16 of Recent Material Developments in Powder Metallurgy. Vol. I. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). (In Russian).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943-(Vol.1).

The technology is described for producing materials reinforced by dynamic hot pressing, in particular the strength of copper and nickel reinforced with tungsten fibers in one or two directions. The diffusion interactions between matrix and fiber in the nickel–tungsten compound was studied. (auth)

21361 NATURE OF DRIVING FORCE FOR ACTIVATED SINTERING. Missol, W. (Inst. of Nonferrous Metals, Gliwice, Poland). pp 15.1-11 of Recent Material Developments in Powder Metallurgy. Vol. II. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943-(Vol.2).

The activated sintering process is considered from a point of view other than the theory that admixture activated sintering is attributed to accelerated diffusion. The ideas of physical chemistry of surfaces are taken into account. It is shown that due to adsorption phenomena of activating admixtures on pore surfaces, an enormous driving force for sintering arises under specific conditions. An equation of the driving force for sintering is provided. It is based on thermodynamic relations of adsorption processes. For defined quotients of surface excess and pore diameter the driving force may be much greater than that derived from the Young-Laplace formula. Theoretical foresights of specimen growth instead of shrinkage are given. (auth)

21362 rf-SPUTTERED CADMIUM SULFIDE THIN CRYSTALS. Lagnado, I.; Lichtensteiger, M. (Massachusetts Inst. of Tech., Cambridge). J. Vac. Sci. Technol.; 7: 318-21(Mar-Apr 1970).

rf-Sputtering techniques have been employed in a diode configuration for the deposition of cadmium sulfide films up to 5 mμ thickness on nonoriented substrates. X-ray diffractometer tracings showed exclusively (000l) peaks with l = 2, 4, 6, . . . , indicating a highly preferred basal plane orientation parallel to the substrate. Electron diffraction patterns, moreover, indicate essentially the same structural features as those obtained from single crystal cadmium sulfide. Results based on x-ray double crystal spectrometry and electrical transport properties are presented as related to sputtering parameters such as rf-power density, argon pressure, substrate temperature, and deposition rate. (auth)

21363 CORROSION RESISTANT PRESSURE VESSELS. Mackenzie, S. J. (Foster Wheeler Corp., Mountaintop, Pa.). Mater. Protect.; 9: 9-13(Jan 1970).

The demand for reliability under severe operating conditions introduces unique design and fabrication techniques for large heavy wall pressure vessels. Manufacturing processes available for forming, welding, and cladding are described, and the considerations of design and process selection are discussed. The primary means of nondestructive testing to assure vessel integrity and the basic elements for developing a quality assurance program are detailed. (auth)

Properties Evaluations

Refer also to abstracts 20939, 20949, 20962, and 22431.

21364 (IS-2044) THE MAGNETIC PROPERTIES OF SINGLE CRYSTALS OF ERBIUM AND SOME YTTRIUM–ERBIUM AND LUTETIUM–ERBIUM ALLOYS BETWEEN 1.2 AND 300°K. Gray, W. J.; Spedding, F. H. (Ames Lab., Iowa). Feb 1968. Contract W-7405-eng-82. 111p. Dep. CFSTI.

Carefully analyzed spherical single crystal samples were prepared of erbium and of alloys whose approximate compositions were: $Y_{25}Er_{75}$, $Y_{50}Er_{50}$, $Y_{75}Er_{25}$, $Lu_{25}Er_{75}$, $Lu_{50}Er_{50}$, and $Lu_{75}Er_{25}$. Magnetic measurements were made on each of these samples along the three principal crystallographic axes in the range 1.2 to 300°K and applied fields up to 27.9 kOe. For pure erbium, the saturation moment along the c-axis was found to be 276.0 ± 2.0 emu/g by fitting the data to a T^2 plot and extrapolating to 0°K. This is to be compared with a theoretical value of 300.5 emu/g. The discrepancy between experiment and theory is apparently the result of a ferromagnetic spiral arrangement of spins where the spins are cocked at an angle to the c-axis rather than being aligned parallel to it. Curie and Néel temperatures were found at 18.2 ± 0.5 and 86.5 ± 0.5°K respectively. Peaks in the c-axis moment vs temperature curves were also observed which extrapolated to zero-field temperatures of 28.0 ± 0.5 and 50.5 ± 0.5°K. The latter corresponds to the transition from one antiferromagnetic structure to another while the significance of the former is unknown. Peaks occurred in both the a- and b-axis moment vs temperature curves below about 18.5 kOe. Below about 10 kOe, the temperature of the peaks was field independent and occurred at about 18.2°K. In both the a- and b-axis moment vs field curves, there were discontinuous increases in moment at about 18.5 kOe near 4.2°K. These apparently correspond to a sudden transition to a nearly parallel alignment of spins at an angle of about 23° to the axis. Some very small basal-plane anisotropy was observed below 40°K. At 4.2°K, the b-axis moment was about 2% larger at high fields. None of the alloys studied were ferromagnetic in zero field. The Néel temperatures of the alloys were proportional to the $^2/_3$ power of the average de Gennes factor, $T_N = AG^{^2/_3}$. The constant, A, was found to be 49.0 for the yttrium–erbium alloys and 53.5 for the lutetium–erbium alloys. An anomalous peak was observed in the c-axis moment vs temperature curves for two alloys, $Lu_{25}Er_{75}$ and $Y_{50}Er_{50}$. In both alloys, the peak was not observed at fields less than about 5 kOe. However, by extrapolating to zero field, the temperatures of the peaks were determined to be 27.5 ± 1.0 and 17.5 ± 1.0°K respectively for the two alloys. In addition to these anomalies, a peak was observed at 29.0 ± 0.5°K for a polycrystalline $Y_{25}Er_{75}$ alloy by a zero-field mutual-inductance bridge technique. These peaks are evidently due to a transition between two different magnetic structures, but whether they correspond to the structure change observed by Child et al. in yttrium-erbium alloys is not known. Peaks occurred in both the a- and b-axis moment vs temperature curves for the $Y_{25}Er_{75}$, $Lu_{25}Er_{75}$, $Y_{50}Er_{50}$, and $Lu_{50}Er_{50}$ alloys at 16.4, 16.1, 12.5, and about 9.0°K respectively. These peaks are apparently related to the 18.0°K basal-plane peak in pure erbium. This peak corresponds to the ferromagnetic-antiferromagnetic transition in pure erbium. The small basal-plane anisotropy observed in the alloys at low temperatures (b-axis moment larger) was found to decrease with increasing temperature and with decreasing erbium concentration. From the paramagnetic data, the magnetic moments, in terms of the effective number of Bohr magnetons per erbium ion, were found to be within experimental error of 9.97 ± 0.1 for erbium as well as for all the alloys. (auth)

21365 (KFK-973) WEAR CHARACTERISTICS OF STEEL AND ALLOYS IN LIQUID SODIUM. Wild, E.; Mack, K.; Hoffmann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Apr 1969. 53p. (In German). (EUR-4174). Dep. CFSTI (U. S. Sales Only).

The selection of materials for bearings and supports in components of a sodium-cooled reactor depends on a knowledge of the wear characteristics of various combinations of materials. As a preliminary study, 36 different combinations of steel and metal alloy bearings were tested under the same operating conditions. Three cylindrical test pieces (fixed pins) were mated to holes in a ring-shaped plate which oscillated in a flowing sodium environment. Wear on the pins was determined. The most favorable material combinations (pin and hole) were used in further parametric studies of the effects of temperature, stress, oscillation frequency, and oxygen content of the sodium. (tr-auth)

21366 (LA-4292-TR) THE ELASTIC PROPERTIES OF PLUTONIUM IN THE BCC EPSILON PHASE. Cornet, J. A.; Bouchet, J. M. Translated by Raymond E. Tate (Los Alamos Scientific Lab., N. Mex.), from J. Nucl. Mater.; 28: 303-10(1968). 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 6687.

21367 (ORNL-TM-2835) CREEP-RUPTURE PROPERTIES OF SU-16 AND THEIR RESPONSE TO HEAT TREATMENT. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The creep-rupture properties of SU-16, a niobium-base alloy (Nb–11% W–3% Mo–2% Hf–0.08% C), have been determined for times up to 1000 hr at 980, 1095, and 1205°C. Creep tests were

performed at pressures not exceeding 2×10^{-7} torr. Results of comparison with other data indicate that Su-16 is one of the stronger niobium-base alloys. The effect of pretest annealing temperature on the creep-rupture properties was studied. Heat treatment at 1425°C weakened the alloy, but heat treatment at higher temperatures up to 1650°C increased strength; these effects persisted for at least 1000 hr. (auth)

21368 EFFECTS OF THERMAL CYCLING AT 77 TO 300°K ON ELECTRIC CONDUCTIVITY OF LANTHANUM AND CERIUM. Pavlov, V. S.; Rybalchenko, N. D. Izv. Akad. Nauk SSSR, Metal.; No. 1, 224-8(Jan-Feb 1970). (In Russian).

The effects of purity on the phase composition of lanthanum and the completeness of phase transformations in cerium during cyclic cooling from room temperature to 77°K were studied. The refining of lanthanum and cerium was performed by zonal melting in an electric field. Residual electric conductivity of the purified metals was less than values given in the literature. Thermal cycling of La below room temperature did not change the ratios of phases in it. An increase in purity for cerium resulted in more complete $\beta \rightarrow \gamma$ transition during cooling. During thermal cycling of cerium below room temperature the process progressed more rapidly for purer metals. (tr-auth)

21369 SOLUBILITY OF OXYGEN IN Nb–Zr ALLOYS. Shurin, A. K.; Loktionov, V. A. Izv. Akad. Nauk SSSR, Metal.; No. 1, 231-3(Jan-Feb 1970). (In Russian).

The phase composition of Nb–Zr rich in niobium was determined by metallographic and x-ray structure analyses. Niobium-base solid solution Nb–Zr–O at 1000 and 1600°C is in equilibrium with ZrO_2, NbO, or with Zr-base solid solution. Zirconium significantly reduced the solubility of oxygen in niobium at 0.025 at. %. The oxidation of niobium by zirconium is described and the alloying compositions were studied. (tr-auth)

21370 SOLUBILITY OF OXYGEN IN LIQUID MOLYBDENUM. Kozina, L. N.; Revyakin, A. V.; Samarin, A. M. Izv. Akad. Nauk SSSR, Metal.; No. 1, 56-64(Jan-Feb 1970). (In Russian).

The determination of the solubility of oxygen in liquid refractory metals in the presence of volatile oxides is reported. The equilibrium constant for the oxygen dissolution reaction in liquid molybdenum at 3000°C is given. (tr-auth)

21371 SOLUBILITY OF YTTRIUM AND MANGANESE IN SOLID MAGNESIUM. Sviderskaya, Z. A.; Padezhnova, E. M. Izv. Akad. Nauk SSSR, Metal.; No. 1, 206-10(Jan-Feb 1970). (In Russian).

The alloys of Mg–Y–Mn containing up to 3 wt % Mn and 15 wt % Y were studied by microstructural measurements and specific electrical resistance. The isothermal cross-sections of Mg–Y–Mn at 500, 400, 300, and 200°C were constructed. The diffusion of Y and Mn slightly decreased in Mg at 300 to 500°C, but the solubility in magnesium was not changed at 200°C. (tr-auth)

21372 THERMAL AND ELECTRIC CONDUCTIVITIES OF SOME Re–Co ALLOYS. Kirichenko, P. I. (All Union Research Inst. of Instrumentation, Moscow). Teplofiz. Vys. Temp.; 7: 682-6(Jul-Aug 1969). (In Russian).

The electric and thermal conductivities of pure cobalt and alloys with rhenium (0.5, 1.0, 2.5, and 5.0 wt %) were studied over the temperature range from 293 to 1123 °K. The thermal conductivity of cobalt and the Co–Re alloys decreased with a rise in temperature while electric conductivity increased. Graphic data on the thermal and electric conductivity of Re–Co alloys as a function of the temperature are analyzed. (tr-auth)

21373 LOW-TEMPERATURE SPECIFIC HEATS OF HEXAGONAL CLOSE-PACKED ERBIUM–THULIUM ALLOYS. Satya, Akella V. S. East Lansing, Mich.; Michigan State Univ. (1969). 108p.

Thesis.

The specific heats of hexagonal close-packed erbium and thulium metals, and three of their isostructural alloys were measured in the liquid-helium temperature range between 1.3 and 4.2°K for examining the validity of the localized 4f-band model, on which the current theories of the rare-earth metals are based. Barring possible uncertainties in the magnetic properties of the samples and their impurity contents, the coefficients of the specific-heat component linear in temperature calculated from the present data range in values approximately two to twenty times the constant electronic specific-heat coefficient predicted by the model for all the hexagonal close-packed rare-earth lanthanides. Possible explanations for such discrepancies are discussed. An itinerant 4f-band model based on the one-electron-band model suggested by Mott is proposed for the lanthanides as an alternative to the localized 4f-band model. (Diss. Abstr. Int., B)

21374 A MEASUREMENT OF THE X-RAY DEBYE TEMPERATURE OF TUNGSTEN IN THE RANGE $4.2°K \leq T \leq 297°K$. Kilbane, Farrell Michael. Columbus, Ohio; Ohio State Univ. (1969). 109p.

Thesis.

The x-ray Debye temperature was determined for tungsten in the temperature range from 4.2 to 297°K. Measurements were made of the intensities of the Bragg reflections of Mo Kα radiation from tungsten powder samples for the four sets of crystallographic planes for which $(h^2 + k^2 + l^2)$ equalled 50, 54, 62, and 66 respectively. Measurements were carried out at 4.2, 20.4, 77.3, 194.6, and 297°K. Values for $\Theta_M(T)$ were calculated in the usual way from the areal intensity ratios at a given angle as a function of the temperature. The most probable value for $\Theta_M(4.2°K)$ was determined to be 300 + 20°K. The shapes of the $\Theta_M(T)$ vs T curves obtained in this experiment were compared with x-ray, specific heat, and neutron scattering data existing in the literature. Although only the x-ray data were susceptible to direct comparison, the results of this experiment provided no obvious support for the reputed peak in the specific heat data. The shape of the $\Theta_M(T)$ vs T curve was not inconsistent with the low temperature portion of the curve calculated from the frequency distribution obtained from inelastic neutron scattering data. However, in the region from 80 to 297°K it was in disagreement with that part of the curve calculated from the frequency distribution which lies in the same temperature region. Possible reasons for the discrepancy in terms of anharmonic forces, volume effects, and the uncertainty in the calculations were investigated. Neither volume effects nor the effects of anharmonic forces seemed adequate to explain the residual differences. Some suggestions were made concerning possible ways of resolving the remaining discrepancies. (Diss. Abstr. Int., B)

21375 FRACTURE INITIATION IN XAP-001 DIPERSION STRENGTHENED ALUMINUM ALLOY. Harman, D. G. (Oak Ridge National Lab., Tenn.); Nolan, T. A. J. Nucl. Mater.; 34: 290-8(Mar 1970).

A unique fractographic analysis technique was developed to study the initiation and propagation of the high-temperature fracture of aluminum dispersion strengthened with Al_2O_3. The formation of voids at the Al_2O_3 sites early in the high-temperature tensile test was verified. The growth of these voids throughout the fracture process was studied for a particular alloy, XAP-001, by measurements of both size and density of voids. Knowledge of the fracture process suggests that a more uniform dispersion of Al_2O_3 particles would improve the high-temperature ductility. (auth)

21376 CALORIMETRIC MEASUREMENT OF THE HEAT OF DISSOLUTION OF YTTERBIUM IN TIN. ENTHALPY OF FORMATION OF THE COMPOUND $YbSn_3$. Chatillon-Colinet, Catherine; Percheron, Annick; Mathieu, Jean-Claude; Achard, Jean-Claude (Ecole Nationale Superieure d'Electrochimie et d'Electrometallurgie, Grenoble, France. Centre National de la Recherche Scientifique, Meudon, France). Compt. Rend., Ser. C.; 270: 473-6(2 Feb 1970). (In French).

The heat of dissolution of ytterbium in tin was measured at 857°K. The limiting value of partial enthalpy for ytterbium at 857°K could be deduced from it: $\Delta H_{(Yb)} = -35.3$ kcal/at-g. The heat of dissolution of the compound $YbSn_3$ having a face-centered cubic structure and a lattice parameter of 4.681 Å, was determined. The heat of formation of $YbSn_3$ at 294°K could be deduced from the ytterbium partial enthalpy: $\Delta H_{(f)} = -42.1$ kcal/mole. (auth) (France)

21377 RECENT MATERIAL DEVELOPMENTS IN POWDER METALLURGY. VOLUME I. Proceedings of the IVth International Powder Metallurgy Conference, Dresden, September 23–26, 1969. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). 262p. (In several languages). (CONF-690943-(Vol.1)).

Twenty-seven papers are included, although for some only abstracts are given. Separate abstracts were prepared for 7 papers. The remaining papers contain information on the preparation and properties of materials not in scope for NSA. (J.C.W.)

For abstracts of individual papers see: 21358–21360, 21378–21380, and 21419.

21378 THE PHENOMENON OF SPIRAL CONCENTRIC GROWTH IN SINTERED MATERIALS. Petrovic, V.; Stevanovic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 14.1-16 of Recent Material Developments in Powder Metallurgy. Vol. I. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943-(Vol.1).

Investigations were performed on UO_2 samples after sintering at temperatures from 900 to 1600°C and in atmospheres of helium, hydrogen, and vacuo. An anlaysis was also made of sintered UO_2 samples of various densities after annealing in helium at 1600 to 1800°C. The spiral concentric growth was observed on fractured surfaces of the sintered samples using an electron microscope. It was concluded that the higher the surface energy, the greater is the polarization of anions, and the greater is the surface energy reduction. In the second test, a decisive effect of oxygen on the nucleation and growth of spiral concentric figures in pores was noted. (J.C.W.)

21379 SINTERING OF TUNGSTEN–RHENIUM ALLOYS. Kaiser, H.; Marx, H.; Saemisch, H.; Staudt, J.; Feiler, U.; Grimm, R. pp 24.1-20 of Recent Material Developments in Powder Metallurgy. Vol. I. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). (In German).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943–(Vol.1).

Compaction behavior of tungsten–rhenium powders caused by reaction sintering in the temperature range below 2000°C and metal powder-doping additions are reported. Sintering by the homogenization of the β-solid solution is of considerable influence on the workability and application of tungsten-rhenium wires. The ductility of annealed wires was investigated at room temperature within the alloy range of 0.5 to 3% rhenium. (auth)

21380 INFLUENCE OF HETEROPHASE COMPOSITION ON THE REDUCTION OF MoO_3 BY HYDROGEN AND SINTERING OF THE OBTAINED MOLYBDENUM POWDER. Lambiev, D. K.; Tomova, T. T.; Samsonov, G. V. pp 25.1-11 of Recent Material Developments in Powder Metallurgy. Vol. I. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). (In Russian).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943–(Vol.1).

Reduction of molybdenum trioxide by hydrogen was studied thermogravimetrically. In the temperature range between 450 and 515°C, a reduction to MoO_2 occurred and this reaction was greatly accelerated by the addition of either nickel or palladium in concentrations between 0.05 to 0.50%. In the temperature range between 700 and 765°C a further reduction to metallic molybdenum appeared, the rate of which, however, was not affected by the previous additions. Powder samples were then sintered in vacuum at 1300°C. The previous additives accelerated the sintering process whereby nickel was more effective than palladium. In addition, the granulometric composition of the powders was studied with repect to the additives. (tr-auth)

21381 RECENT MATERIAL DEVELOPMENTS IN POWDER METALLURGY. VOLUME II. Proceedings of the IVth International Powder Metallurgy Conference, Dresden, September 23–26, 1969. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). 243p. (In several languages). (CONF-690943–(Vol.2)).

Twenty-one papers are included; separate abstracts were prepared for 4. The abstracts of two of the papers are included in Volume I. The remaining papers contain information on the preparation and properties of materials not in scope for NSA. (J.C.W.)

For abstracts of individual papers see: 21361, 21382, 21393, and 21433.

21382 DETERMINATION OF STATIC AND FATIGUE STRENGTH OF HARD METALS. Johansson, I.; Persson, G.; Hiltscher, R. (Sandvikens Jernverks Aktiebolaget, Stockholm). pp 36.1-19 of Recent Material Developments in Powder Metallurgy. Vol. II. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943–(Vol.2).

The special procedures required for the assessment of the extremely high static and fatigue compressive strength of hard metals are reviewed. Results are reported from experiments where test pieces with enlarged ends were used. They were found to give consistent strength data with low scatter. Values are reported for WC–Co compositions in the range 10 to 44 volume per cent Co and with different WC grain size. The ultimate compressive strength varied between 330 and 680 kgf/mm^2 (3300 to 6800 MN/m^2) with a coefficient of variation in the interval 0.5 to 3%. In fatigue testing, failure had occurred after 2×10^6 cycles at a load of 65 to 85% of the static compressive strength. (auth)

Structure and Phase Studies

Refer also to abstracts 21381 and 21883.

21383 (CALT-221-83) LATTICE SPACINGS AND MAGNETIC SUSCEPTIBILITIES OF Pd–La, Pd–Ce, AND Pd–Pr ALLOYS. Speight, J. D. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Jan 1970. Contract AT(04-3)-221. 12p. Dep. CFSTI.

Results of measurements, using a null-coil pendulum magnetometer, as function of the applied field at 2.45 to 8.4 kOe at several temperatures from 0 to 300°K are presented. (J.R.D.)

21384 PHASE DIAGRAM OF Hf–Al. Tsyganova, I. A.; Tylkina, M. A.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal.; No. 1, 160-3(Jan-Feb 1970). (In Russian).

The phase diagram and composition diagram were constructed from physico-chemical studies. Hafnium and aluminum form the phase diagram with limited reciprocal solubility and by six chemical compounds of different crystalline structures. Periods of certain crystalline structures were calculated. The temperature of solubility of Al in Hf was found. The region of treated alloys of Al, alloyed by Hf up to approximately 20 wt % was established. (tr-auth)

21385 PHASE EQUILIBRIUM IN Ti–Ta–Cr. Gavze, A. L.; Budberg, P. B. Izv. Akad. Nauk SSSR, Metal.; No. 1, 184-8 (Jan-Feb 1970). (In Russian).

The isothermal sections of Ti–Ta–Cr were constructed at 600 and 700°C by microstructural and x-ray phase analyses. Four polythermal sections were constructed which contain Ti and Ta in the ratios of 4 to 1, 3 to 2, 2 to 3, and 1 to 4. (tr-auth)

21386 INVESTIGATION OF PART OF Ti–Ta–V PHASE DIAGRAM. Mikheev, V. S.; Nikitin, P. N. Izv. Akad. Nauk SSSR, Metal.; No. 1, 189-92(Jan-Feb 1970). (In Russian).

The phase diagram was constructed according to the microstructural and partial x-ray structural analyses, measurements of electrical resistance at 20 to 1100°C, and determinations of temperatures at melting points of the alloys by an optical pyrometer. The results showed that tantalum and vanadium form continuous solid solutions with beta-titanium and have limited solubility with alpha-titanium. (auth)

21387 PHASE STRUCTURE AND HEAT RESISTANCE OF Ti_3Al–Nb. Andreev, O. N. Izv. Akad. Nauk SSSR, Metal.; No. 1, 193-6(Jan-Feb 1970). (In Russian).

The results of the investigation of phase equilibrium and thermal resistance of Ti_3Al–Nb are reported. Ti_3Al was formed from beta-solid solution in Ti–Al at 1130°C and had the hexagonal structure of Mg_3Gd. The phase equilibrium diagram of Ti_3Al–Nb was constructed from thermal and microstructural analyses. Niobium decreased the temperature of the polymorphic transformation. The chemical interaction of elements in the system was confirmed by the study of concentrated relations of hardness, electrical resistances, and the densities of the alloys. The maximum heat resistance occurred at 80 to 81 wt %, Ti; at 15 to 16 wt %, Al; and at 3 to 5 wt %, Nb. (J.C.W.)

21388 PHASE DIAGRAM OF W–Ti–Si. Maksimov, V. A.; Shamrai, F. I. Izv. Akad. Nauk SSSR, Metal.; No. 1, 197-201 (Jan-Feb 1970). (In Russian).

The investigation of W–Ti–Si was conducted by thermal, microstructural, x-ray, and phase analyses, and by hardness and microhardness measurements. In the Ti–Si system, it was found that at 1170°C, Ti_5Si is formed according to peritectoid reactions. In the W–Si system, it was found that W_5Si_3 is melted congruently at approximately 2330°C. The quasi-binary sections were constructed for W_5Si_3–Ti_5Si_3, WSi_2–$TiSi_2$, W–Ti_5Si_3. (tr-auth)

21389 KINETICS OF SOLID-PHASE REACTIONS IN Mo–Be–Zr AND W–Be–Zr. Panov, A. S.; Rysina, M. M. Izv. Akad. Nauk SSSR, Metal.; No. 1, 202-5(Jan-Feb 1970). (In Russian).

The kinetics and mechanisms of reactions of Mo and W with Be and Zr were studied. For tungsten at 900 to 1150°C, the process of reaction was limited by the kinetic stage and at 1200 to 1500°C, by diffusion. For molybdenum, reactions at 900 to 1400°C were limited by kinetics. The energy of activation for each process is given. (tr-auth)

21390 PHASE COMPOSITION OF Nd–Fe–Al WITH 0 TO 33.3 AT. PERCENT Nd. Vivchar, O. I.; Zarechnyuk, O. S.; Ryabov, V. R. Izv. Akad. Nauk SSSR, Metal.; No. 1, 211-13(Jan-Feb 1970). (In Russian).

Forty-nine ternary alloys of Nd–Fe–Al with 0 to 33.3 at. % Nd were studied by x-ray structure analysis. The isothermal cross section was studied at 500°C. Four ternary phases established were $NdFe_{9.3\to4}Al_{3.7\to3}$; $Nd_2Fe_{17\to8.5}Al_{6\to8.5}$; $NdFe_2Al_{10}$; and $NdFe_{1.2\to1.45}Al_{0.8\to0.55}$. (auth) (TSS)

21391 SYNERGY OF LINE PROFILE ANALYSIS AND SELECTED AREA TOPOGRAPHY OF BERYLLIUM BY THE

X-RAY DIVERGENT BEAM METHOD. Glass, Howard L. New Brunswick, N. J.; Rutgers–The State Univ. (1969). 128p.

Thesis.

A technique is presented for obtaining absorption profiles and selected area diffraction topographs by the x-ray divergent beam transmission method. The absorption profiles are extracted from the intensity profiles of the deficiency conics by unfolding the spectral distribution using Stokes' method. X-ray diffraction topographs are obtained from the accompanying diffraction conics by repositioning the specimen and inserting an appropriate aperture. A grid technique is used to guide the repositioning of the specimen so that the crystal volume which is imaged in the topograph is the same volume which produces the selected area of the deficiency conic pattern which is examined by profile analysis. If the selected area contains an intersection of deficiency conics, topographs and absorption profiles may be simultaneously obtained from two or more sets of (hkl) planes all lying within a small crystal volume. Deficiency conic profile analysis provides a quantitative measure of crystal imperfection while x-ray diffraction topography affords a pictorial representation of crystal defect structures. Since the two techniques when used together yield a more thorough description of the defect structure than can be obtained by application of the two techniques individually, the simultaneous combination of deficiency conic profile analysis and selected area diffraction topography is termed the synergy method. The synergy method was employed in an investigation of the deformation properties of beryllium single crystals at room temperature. The deformation was accomplished by compression of the specimens while in place on the divergent beam apparatus. Specimens oriented for the activation of basal slip, prism slip, and for c-axis compression were studied. The synergy method was applied at several intersections of deficiency conics so as to obtain information about the anisotropy and inhomogeneity of the deformation behavior. It was determined that the specimens examined contained a considerable grown-in substructure consisting, typically, of large columnar subgrains having misorientations principally around the c-axis. The grown-in substructure plays a significant role in blueprinting the response of the crystals to deformation. (Diss. Abstr. Int., B)

21392 DEFECTS IN QUENCHED ZIRCONIUM. Swanson, M. L.; Piercy, G. R.; Kidson, G. V.; Quenneville, A. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 34: 340-2(Mar 1970).

The defect concentration which was retained in quenched high-purity zirconium wires was estimated from electrical resistivity measurements. The results are summarized. (G.M.C.)

21393 CARBIDE PHASES IN SINTERED IRON ALLOYS. Jellinghaus, W. (Max-Planck-Inst. fuer Eisenforschung, Duesseldorf). pp 41.1-8 of Recent Material Developments in Powder Metallurgy. Vol. II. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). (In German).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943–(Vol.2).

During annealing the affinity of the carbide formers (Cr, Mo, Ti etc.) to carbon which are superior to that of iron leads to changes in the carbide phases. In iron materials containing several alloy metals not only iron and alloying elements but also the metals among one another compete with carbon. The testing of alloys of high C and metal contents determined the distribution of carbon, substituted carbide phases, and ternary carbides. Up to now ternary and quaternary alloys such as Fe–(Cr, Ti, Mo, W)–C and Fe–(Mo, W)–Cr–C have been investigated. The results given are valid for annealing conditions below perlite temperature. Their application to steels and cast alloy long-time heat-treated has been examined. (auth)

21394 THE STRUCTURE ANALYSIS OF β-RHOMBOHEDRAL BORON. Hoard, J. L.; Sullenger, D. B.; Kennard, C. H. L.; Hughes, R. E. (Cornell Univ., Ithaca, N. Y.). J. Solid State Chem.; 1: 268-77(1970).

A detailed discussion of the analysis of the structure of β-rhombohedral boron, β-B_{105}, is presented. Several formulations of the icosahedral framework structure are fully elaborated and detailed variations in bond lengths and bonding geometries are discussed. Perturbations of the ideal structure are effected through partial occupancies, substitutional atoms, and local disorders in framework and interstitial sites. (auth)

Radiation Effects

Refer also to abstracts 21854, 22403, and 22423.

21395 (AD-698275) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August 1–October 31, 1969. Steele, L. E.; Hawthorne, J. R.; Watson, H. E.; Serpan, C. Z. Jr.; Gray, R. A. Jr. (Naval Research Lab., Washington, D. C.). 15 Nov 1969. 27p. (NRL-MR-2058). CFSTI.

Developments are reported for: initial comparisons between dynamic tear test and Charpy V-notch impact data for irradiated steels, including the PM-2A vessel steel; the recovery of ductility by annealing heat treatment of steels irradiated to different ratios of thermal to fast neutrons; the unirradiated properties of special A533-B steel heat procured for low embrittlement sensitivity; data describing the thermal stability of a potential advanced reactor structural alloy, 5Ni–Cr–Mo–V steel; and initial strength and ductility data on selected austenitic stainless steels, 304, 304L, 316, and 316L, after irradiation in the EBR-II reactor to fluences between 0.4 and 9.0 × 10 to the 20th power n/sq cm >1 MeV at temperatures ranging from 700 to 830°F. (auth) (USGRDR)

21396 (BMI-1878, Sect.B) CLADDING, STRUCTURAL, AND COMPONENT MATERIAL STUDIES. (Battelle Memorial Inst., Columbus, Ohio). 20p.

A program to determine the effects of the magnitude and nature of reactor environments on various reactor cladding and structural materials is described. The portion of the program involving irradiation effects is directed toward obtaining an understanding of the radiation-induced high-temperature embrittlement observed in potential cladding materials for liquid-metal fast breeder reactors (LMFBR). Emphasis is being placed on the irradiation behavior of AISI Type 347 and Type 316 stainless steel. The program is divided into efforts concerning the mechanical properties of Type 347 stainless steel irradiated to very high thermal and fast fluences, the effect of microstructure on the radiation-induced high-temperature embrittlement, the development and evaluation of new techniques for determining radiation-induced mechanical property changes, the effect of irradiation temperature, dose rate, and flux spectrum on the mechanical properties of cladding materials, and the evaluation of requirements for and the determination of properties of LMFBR structural and component materials. (auth)

21397 (CONF-680322-5) CHANGES IN LENGTH AND OF THE ELECTRIC RESISTANCE OF URANIUM UNDER REACTOR RADIATION AT 4.6°K. Goeller, S.; Vogl, G.; Wenzl, H. (Technische Hochschule, Munich (West Germany)); Jousset, J. C.; Quere, Y. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 10p. (In German). Dep. CFSTI (U. S. Sales Only).

From Conference on the Physics of Metals, Berlin, Germany.

The elongation of uranium wires during thermal neutron irradiation at 4.6°K and after isochronous recovery was compared with the change of the electrical resistance in order to determine if the elongation is the result of a thermal diffusion process of defects. The experimental conditions are described and the results were reported. It was concluded that the electrical resistance attains during irradiation with thermal neutrons at 4.6°K almost complete saturation after 10^{17} n/cm^2. For its recovery individual defect sites and probable agglomerates are responsible. Its development is as independent as possible from those arising in agglomerates, which require a higher dose for attaining saturation concentration than individual defects. The elongation is almost at the limit at 4.6°K. It shows in contrast to earlier assumptions –at least at low doses –a dose dependence or saturation tendency. The initial value of the elongation is much greater than the previously measured values after higher doses and temperatures. It can be traced to the formation of agglomerates. A possible mechanism for these results is described. (J.S.R.)

21398 (PEL-194) STUDY OF FISSION PRODUCT RELEASE AND FUEL EVAPORATION BY FISSION FRAGMENT RECOIL FOR THE PELINDUNA REACTOR CONCEPT. Steyn, W. M.; Turkstra, J.; de Wet, W. J. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct 1969. 38p. Dep. CFSTI (U. S. Sales Only).

A review of fission fragment irradiation of materials, with special emphasis on surface effects on nuclear fuels, is presented. Experiments conducted to study the recoil release of fission products and fuel particles from neutron irradiated uranium metal, are discussed. (auth)

21399 DEFECTS PRODUCED BY keV GOLD ION BOMBARDMENT OF GOLD ALONG CHANNELING DIRECTIONS. Schober, Tilman Richard. Ithaca, N. Y.; Cornell Univ. (1969). 122p.

Thesis.

Defects produced by keV gold ion bombardment of gold along channeling directions at room temperature were investigated. Using transmission electron microscopy, the nature and mode of formation of defects arising from such bombardment was stud-

ied. In addition, the interaction of channeled gold ions with lattice imperfections such as planar defects and the nature of defects produced by channeled ions was investigated. For bombardment with 3 to 40 keV gold ions along [001] the defects were found to be point defect clusters of vacancy type. Above 15 keV the defects were mainly dislocation loops; below 15 keV they appeared to be centers of dilatation. Furthermore, the defects were shown to be formed in situ at sites of displacement cascades produced by the dechanneling of incident channeled gold ions at thermally displaced atoms. No threshold knock-on energy of about 25 keV for the in situ formation of visible clusters in gold—as proposed by other authors—was found. Defect depth distributions were measured for bombardment along [001] as a function of energy (5 to 120 keV) and for bombardments of fixed energy (40 keV) as a function of the channeling direction (i.e., [111], [011] and [001]). It was concluded that serious glissile losses of visible defects to the surface occurred within 100 to 200 Å of the surface. The defect depth distributions in the regions unaffected by surface losses agreed reasonably well with corresponding radioactive ion penetration data. The geometrical arrangement of subclusters formed in the subcascade regions of large displacement cascades was investigated for 120 keV gold ion bombardment along [001] using electron stereo microscopy. A model for the production of the observed subclusters was proposed. It was concluded that a substantial portion of the total energy of the incident ion was used to produce the subclusters. Also, many of the energetic particles which produced the subcascades must have been quasi-channeled. Using silver-gold sandwich type single crystal specimens, it was demonstrated that planar defects defocus gold ions channeled along [001]. The geometry of the blocking of [001] channels in an fcc lattice by (111) planar faults was described. It was shown that 40 keV gold ions entering gold films only via the channeling mechanism produce vacancy clusters at sites of displacement cascades which are caused by dechanneling events at thermally displaced atoms. (Diss. Abstr. Int., B)

21400 ELECTRON IRRADIATION HARDENING IN FACE-CENTERED-CUBIC METALS. Mifune, Tsuyoshi. Evanston, Ill.; Northwestern Univ. (1969). 179p.

Thesis.

The effect of electron irradiation on the mechanical properties of face-centered-cubic metallic single crystals (copper, aluminum and aluminum-1 at. % zinc) was experimentally investigated at cryogenic temperatures. Thin specimens (0.3 ~ 0.7 mm thick) were tensile-tested after irradiation near liquid hydrogen temperature or liquid nitrogen temperature. The incident electron energy used in this investigation was 2 MeV for copper and 1 MeV for aluminum and aluminum-1 at. % zinc. The range of electron dosage was 1.4×10^{15} ~2.2×10^{17} e/cm^2. The important effects of irradiation on the mechanical properties are as follows: (1) A large increase in the yield stress which is proportional to the square root of the electron dose. (2) A large extension of the easy glide region up to the maximum theoretically expected value. (3) An appreciable overshoot of the tensile axis. (4) A large increase in the strain rate sensitivity of the flow stress which is proportional to the yield stress increase. (5) A small increase in the work-hardening rate in the easy glide region. (6) More uniform distribution of the slip activity. These effects are larger with increasing irradiation and testing temperatures. The hardening, $\Delta\tau$, due to electron irradiation is approximately expressed by: $\Delta t = \alpha\mu C^{\frac{1}{2}}$ where μ is the shear modulus of the material, C is the concentration of the electron-induced defects and α is the hardening coefficient. The hardening coefficient, α, measured at liquid hydrogen temperature was ~$\frac{1}{18}$ for copper and ~$\frac{1}{4}$ for aluminum and aluminum-1 at. % zinc. As these hardening coefficients are at least one order of magnitude larger than the corresponding coefficient in quenched materials, the observed hardening in as-irradiated metals is considered to be due to interstitials produced by electron irradiation. The aforementioned irradiation effects on mechanical properties were interpreted as the consequence of lattice hardening due to interstitials dispersed in the matrix. The physical origin of the smaller hardening observed in copper as compared to that in aluminum or aluminum-1 at. % zinc was not clarified, but a thermodynamic analysis of plastic deformation indicated that it is due to the longer interaction range between a dislocation and an electron-produced interstitial in copper. It was discovered that the nature of the interaction between a dislocation and an interstitial is, from this analysis, very similar to that between a dislocation and a deformation-produced defect (presumably a forest dislocation). The recovery of the electron-induced hardening in copper was also studied. Since the recovery of the hardening was parallel to the recovery of the resistivity, it was concluded that the reduction of the number of interstitials by the recombination with vacancies is the cause of the recovery in Stage I and that the remaining hardening after Stage I is also due to dispersed interstitial type defects. This view is supported by other various observations in the present study. The conclusion also applies to aluminum and aluminum-1 at. % zinc. Elasticity calculations were performed to estimate the hardening due to misfit defects. The calculations showed that the observed hardening can be explained by the interaction between a dislocation and either a (100) split-interstitial or a body-centered interstitial. Therefore, the crystallographic nature of the electron-irradiation-induced interstitials remains to be clarified. (Diss. Abstr. Int., B)

21401 HELIUM PRODUCTION IN REACTOR MATERIALS. Birss, I. R. (United Kingdom Atomic Energy Authority, Windscale, Eng.). J. Nucl. Mater.; 34: 241-59(Mar 1970).

Triple fission, α decay, and interactions between nuclei and fission neutrons can all lead to the production of alpha particles in reactor material. These particles can accumulate to form helium gas. The best available data and methods of calculating the production rates are given with particular reference to fast reactors because all (n,α) reactions, except those with the ^{10}B isotope, require fast neutrons. Actual production rates are given for reactor fuel, cladding material, and coolant. The data are presented in such a way that a quick assessment of helium content in a material for a particular case can be obtained. (auth)

21402 NEUTRON IRRADIATION AND DEFECT RECOVERY OF TUNGSTEN. Keys, L. K.; Moteff, J. (General Electric Co., Cincinnati). J. Nucl. Mater.; 34: 260-80(Mar 1970).

A detailed study of the recovery of defects in tungsten after fast neutron ($E_n \geq 1$ MeV) irradiation at about 70°C over a fast neutron fluence range from 8.5×10^{17} to 1.5×10^{21} n/cm^2 was completed. Three principal recovery regions were observed at about 0.15 T_m, 0.22 T_m, and 0.31 T_m where T_m is the melting temperature of tungsten in °K. The 0.15 T_m recovery involved an activation energy of about 1.7 eV and second-order kinetics. A shift of this recovery, with increasing neutron fluence, to lower temperatures was in keeping with second-order kinetics. These results are completely compatible with essentially a mobile self-interstitial, immobile vacancy, recovery process. The 0.22 T_m recovery is suggested to be due to divacancy migration on the basis of its relative magnitude. The 0.31 T_m recovery involved a first-order process with an activation energy of 3.3 eV in excellent agreement with other studies of monovacancy recovery. A non-annealing residual resistivity remaining after completion of the annealing studies was shown to be due to rhenium. Rhenium was produced from the transmutation of tungsten by the β-decay of unstable isotopes of tungsten formed by thermal-neutron (n,γ) reactions. Rhenium appeared to appreciably influence the migration energies for the various defects when its concentration was of the order of one atomic percent or greater. Small recoveries were also observed at about 0.27 T_m and 0.35 T_m. It is suggested that these recoveries may be due to the annealing of trivacancies and defect clusters or loops, respectively, with polygonization also contributing to the latter. (auth)

21403 ELECTRON MICROSCOPE IN SITU ANNEALING STUDY OF VOIDS INDUCED BY IRRADIATION IN ALUMINUM. Packan, N. H.; Braski, D. N. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 34: 307-14(Mar 1970).

The shrinkage of irradiation-induced voids in 8001 aluminum alloy and pure aluminum (Cominco Grade 69) was investigated by annealing thin-foil specimens in a high-vacuum electron microscope. The general shrinkage characteristics of both materials were quite similar, but the shrinkage curves for individual voids showed considerable variation. Most of the voids exhibited an initial high rate of shrinkage. Both effects may reflect the influence of unresolvable local vacancy sinks. (auth)

21404 THERMAL HARDENING IN NEUTRON IRRADIATED VANADIUM. Venetch, J.; Johnson, A. A.; Mukherjee, K. (Polytechnic Inst. of Brooklyn). J. Nucl. Mater.; 34: 343-4(Mar 1970).

The tensile properties of vanadium wire, irradiated with an epithermal neutron dose of about 10^{18} nvt, were studied after individual lengths were isothermally annealed at 102 to 605°C. It was found that the annealing of point defects at about 170°C resulted in a substantial hardening effect, which together with the original irradiation hardening, annealed out at about 600°C. (G.M.C.)

21405 INCREASE IN THE MOBILITY OF ATOMS IN THE METAL SYSTEMS DURING IRRADIATION. Dekhtyar, I. Ya.; Shalaev, A. M. (Inst. of Physics of Metals, Kiev). Ukr. Fiz. Zh.; 15: 77-80(Jan 1970). (In Russian).

On the basis of analysis of information on the theory of diffusion and the influence of irradiation on diffusion processes, a supposition is made that the change in the energetic states of electrons during irradiation gives rise to the diffusional mobility of atoms. (auth)

21406 X-RAY INVESTIGATION OF MOLYBDENUM AND NICKEL IRRADIATED WITH HELIUM IONS. Bykov, V. N.;

Zdorovtseva, G. G.; Troyan, V. A.; Khaimovich, V. S. (Physics Engineering Inst., Moscow). Ukr. Fiz. Zh.; 15: 136-9(Jan 1970). (In Russian).

The changes in polycrystalline Mo and Ni specimens caused by He ion bombardment with an energy of 60 keV were investigated (irradiation dose was $10^{15}-10^{20}$ particles/cm^2. The D-pattern of the irradiated specimens proved to be essentially different from that for reference specimens, some lines being split. These changes depend upon the integral irradiation dose. It appears to result from the tetragonal distortion of the lattice form. The changes decrease in annealing and disappear completely at a temperature of about 400°C. (auth)

21407 INVESTIGATION OF LOCAL DISTRIBUTION OF POINT DEFECTS IN γ-IRRADIATED METALS. Malinenko, I. A.; Shivrin, O. N (Petrozavodsk State Univ., USSR). Ukr. Fiz. Zh.; 15: 150-3(Jan 1970). (In Russian).

Metals containing impurities (Mo-99.98%, Ni-99.9%, Cu-99.99%) were subjected to γ-irradiation (maximum dose of irradiation is 10^7 R). The observed increase in the intensity of diffuse scattering by γ-irradiated metals is explained by the presence of point defects fixed in the crystal lattice by impurity atoms. The character of change in the defect concentration determined from the comparison of theoretical and experimental values of diffusion background intensity is in agreement with the data concerning the change in the lattice parameter of these metals. (auth)

21408 EFFECT OF γ-IRRADIATION ON THE PROCESS OF PUBLISHING SHORT-RANGE ORDER IN α-CuAl. Kulmanen, E. V.; Shivrin, O. N. (Petrozavodsk State Univ., USSR). Ukr. Fiz. Zh.; 15: 154-7(Jan 1970). (In Russian).

The effect of γ-irradiation was investigated on the short-range order in the alloys α-CuAl containing 11.9, 14.3 and 15.9 at. % Al. Comparison of diffuse intensity distribution from the alloy samples before and after irradiation showed, that γ-irradiation from the source ^{60}Co with integral doses 10^6 and 10^7 R did not affect noticeably the value of short-range order maximum. An increase in the irradiation dose up to 10^8, 5×10^8, and 10^9 R results in intensification of diffuse background modulation due to the presence of a short-range order in the alloys with respect to the Laue scattering. Results of analysis on the short-range order coefficients showed that γ-irradiation with the mentioned doses increases the short-range order in case of all the alloys studied. The observed increase in the short-range order in the process of irradiation is due to the intensification of diffuse mobility of atoms with introduction of non-equilibrium concentration of defects as a result of irradiation, which provides the short-range characteristic of a lower temperature range for which the establishment of equilibrium atomic arrangement in the process of ordinary thermal annealing is not attained because of small atom mobility. (auth)

Ceramics and Cermets

Refer also to abstracts 21336–21338.

21409 (BMI-1878, Sect.A) URANIUM–PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS. (Battelle Memorial Inst., Columbus, Ohio). 36p.

Studies are being conducted to evaluate the potential of mixed UN-PuN fuels for fast breeder applications. The program is divided into efforts involving the preparation of materials by gas-solid reactions, property determinations, irradiation studies, and supporting studies. Physical properties of importance for reactor design are being determined, including volatility tendencies, conductivity, expansivity, and chemical stability of the fuels in contact with potential LMFBR cladding materials. The resistance of nitride materials to both thermal and fast flux irradiations will be determined to evaluate the suitability of these fuels for applications involving long-term irradiations. The evaluation of sodium bonding of the fuel to the cladding is another objective of the program. Nitride fuel will probably grow at a rate of about 0.5 vol % per 10^{20} fissions per cm^3. To minimize cladding deformation, this fuel growth can probably be accommodated more effectively in the annulus between the fuel and the cladding rather than in the porosity in the fuel. To minimize fuel temperatures, another desirable objective, this annulus must be filled with a good heat-transfer material. Effort is thus devoted to studies of sodium bonding and film formation in contact with nitride fuels and their claddings. (auth)

Corrosion and Erosion

21410 (AI-AEC-MEMO-12725) THERMAL CYCLE TESTING OF THE ADVANCED ZrH REACTOR CONTROL DRUM BEARINGS. Horton, P. H. (Atomics International, Canoga Park, Calif.). 27 Jun 1968. 48p. Dep. CFSTI.

The Advanced ZrH Reactor Bearings have completed thermal cycle testing and post test inspection. Bearings were thermal cycled between ambient and 1500°F at a vacuum of 10^{-5} torr or lower. Bearing friction torque was recorded at ambient, 800, and 1500°F during 27 thermal cycles and approximately 2300 hours at vacuum. Over 1000 hours at 1500°F were accumulated. Maximum friction torque and friction coefficients are given. Bearing conditions following the test were excellent with well developed carbon-graphite transfer films and no signs of Al_2O_3 coating failure. The test also demonstrated the excellence of the Ta10W test fixture design in performing at temperatures to 1500°F. (auth)

21411 OXIDATION BEHAVIOR OF ThO_2–UO_2 SOLID SOLUTION. Furuya, H. (Tohoku Univ., Sendai). J. Nucl. Mater.; 34: 315-24(Mar 1970).

Several solid solutions having the general formula $Th_yU_{1-y}O_2$ were oxidized in air under conditions of linearly increasing temperature from room temperature to 600°C. Thermogravimetric traces of air oxidation showed three forms with increasing ThO_2 content. The oxidation of ThO_2-UO_2 solid solution containing less than 20 mole% of ThO_2 proceeded through two distinct oxidation stages in the same manner as UO_2. The solid solutions containing 25 and 30 mole% oxidized to $Th_yU_{1-y}O_{2.33-2.35}$ in the first oxidation stage and subsequently to $Th_yU_{1-y}O_{2.35-2.37}$ having a cubic structure in the second oxidation stage. Only one oxidation stage was observed in the oxidation of the solid solution containing more than 40 mole% of ThO_2. Particle size, heating rate and specimen mass influenced the oxidation behavior. (auth)

21412 EFFECT OF CARBON MONOXIDE ON THE RATE OF OXIDATION OF CHARCOAL, GRAPHITE, AND COKE IN CARBON DIOXIDE. Turkdogan, E. T.; Vinters, J. V. (United States Steel Corp., Monroeville, Pa.). Carbon; 8: 39-53(Feb 1970).

The rate of oxidation of coconut charcoal, electrode graphite and metallurgical coke granules in CO_2-CO and $CO_2-CO-He$ gas mixtures at various pressures was measured within the range of 700 to 1400°C. The rate measurements were made under conditions such that almost complete internal burning prevailed, at temperatures below 1000 or 1200°C depending on the type of carbon. CO is found to have a pronounced retarding effect on the rate of oxidation in CO_2, which is attributed to the strong chemisorption of CO on the pore surface of carbon. The experimental results (for the case of almost complete pore diffusion) can be interpreted reasonably well in terms of a reaction mechanism involving two consecutive rate-controlling reactions in series: dissociation of CO_2 on the surface of carbon; and formation of CO on the surface of carbon. CO has a two-fold poisoning effect: covering of the surface site due to strong adsorption, and increasing the activity coefficient of the activated complex for the dissociation of CO_2; hence CO changes the rate-controlling mechanism to the first one. The temperature dependence of the rate parameters is obtained from the rate data for these two mechanisms. In addition, adsorption isotherms are derived indirectly from the rate data for adsorption of CO on the surface of carbons. (auth) (UK)

Preparation and Fabrication

Refer also to abstracts 20948, 21377, and 21848.

21413 (LA-4283) SYNTHESIS AND FABRICATION OF PURE, SINGLE-PHASE, URANIUM–PLUTONIUM MONOCARBIDE PELLETS. Shupe, M. W.; Ogard, A. E.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Jul 1969. 11p. Dep. CFSTI.

A process for producing pure, single-phase, (U,Pu)C solid solution pellets is described. Pellet dimensions, density, chemical composition, and microstructure were determined as functions of processing conditions. (auth)

21414 (ORNL-TM-2872) FORMATION OF ThO_2 MICROSPHERES BY A FREEZE-FORM VACUUM-DRY TECHNIQUE. Bowman, R. A. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 9p. Dep. CFSTI.

The feasibility of producing microspheres from sols by a freeze-form vacuum-dry process was demonstrated. Thoria microspheres were formed by injection of sols of various concentrations into a cooling bath of trichloroethylene at -20°C, dehydration for 1 to 6 hr at 1×10^{-6} torr, and calcination for 4 to 6 hr at 1000 to 1800°C. Microspheres with densities of 17 to 64% of theoretical were successfully produced. (auth)

21415 SOME ASPECTS OF THE PREPARATION OF BORON CARBIDE FOR NUCLEAR TECHNOLOGY. Constantinescu,

Florica; Criveanu, Cornelia; Prodan, Ana (Inst. of Physics, Bucharest). Rev. Roum. Phys.; 14: 579-85(1969).

Procedures for preparing boron carbide are presented. Experimental results obtained during preparation of high-purity boron carbide for use in nuclear technology are summarized. By systematic studies, a procedure was developed for the preparation of boron carbide at low temperatures (1450 to 1500°C), in high-purity crystallite form and having a conversion ratio of original boron in carbide of 60% to 70%. (auth)

21416 SYNTHESIS OF NEW ILMENITE-TYPE DERIVATIVES, $CuVO_3$ AND $CoVO_3$. Chamberland, B. L. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Solid State Chem.; 1: 138-42(Jan 1970).

The compositions $CuVO_3$ and $CoVO_3$ were studied at high pressure in a tetrahedral anvil press. Reactions of CuO and V_2O_4 or Cu_2O and V_2O_5, as well as the conversion of $\alpha CuVO_3$ to a high-pressure phase, were investigated. Two related golden phases, a triclinic, distorted ilmenite, $CuVO_3$(I), and a rhombohedral ilmenite, $CuVO_3$(II), were isolated. Magnetic and resistivity measurements are reported for both high-pressure phases. These phases give the known $\alpha CuVO_3$ when heated above 340° at one atmosphere of pressure. Triclinic, ilmenite-type $CoVO_3$, isostructural with $CuVO_3$(I), was prepared in the reaction of CoO and V_2O_4 at 65 kbars pressure. The magnetic properties show the composition to be ordered below a Néel temperature of 142°K. (auth)

21417 REFRACTORY METALLIZATION OF GREEN CERAMIC. Chance, Dudley A. (IBM Components Div., Hopewell Junction, N. Y.). Met. Trans.; 1: 685-94(Mar 1970).

Successful refractory metallization of green ceramic is shown to require close matching of the shrinkages of the metal layer and the ceramic substrate. Selection of specific metal particle sizes is used as the prime controlling parameter for metallizing several alumina ceramic types, including commercially pure alumina. Warpage of the fired part and adhesion of the metallization are demonstrated to be dependent on the controllable by the choice of metal particle distribution. Properly selected particle distribution results in flat metallized ceramic parts and good adhesion is obtained with pure elemental particles; other additives are unnecessary. X-ray stress analysis data and warpage results are correlated with pull strength measurements. (auth)

21418 NUCLEAR TECHNOLOGY. Altmann, B. R. Chem. Ztg.; 93: 563-4(20 Jul 1969). (In German).

Developments in the German and European nuclear industry are described. Of particular interest are graphite materials which are now close to the production stage. Due to its favorable nuclear properties and high temperature resistance, the use of graphite is projected beyond the present generation of commercial nuclear plants to the gas-cooled high-temperature reactors. A synthetic carbon foam material has been developed by means of a heat treatment process which yields as end product a carbon foam of extreme heat resistance and excellent thermal insulation properties, in conjunction with a very light weight compound to other insulation materials. Covered with a graphite foil, carbon foam provides very good insulation under irradiation conditions. Graphite fiber-reinforced synthetic materials are comparable to steel in strength but are much lighter (20%) and their potential use for gas centrifuges is projected. (BBB) (TSS)

21419 A CONTRIBUTION TO THE COLD PRESSING PHENOMENON OF UO_2 POLYDISPERSE POWDERS. Delic, D.; Stamenkovic, I.; Zivanovic, B.; Ristic, M. M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 6.1-13 of Recent Material Developments in Powder Metallurgy. Vol. I. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943-(Vol.1).

The behavior of uranium dioxide powders during pressing is directly influenced by their physical properties. Results showed that the total specific work of pressing increased for powders undergoing larger contractions during pressing. It was assumed that the total work of pressing dissipates external friction (between powder and die walls), internal friction (between powder particles), elastic deformation of punches, elastic deformation of compacts, and agglomerate fragmentation. (J.C.W.)

Properties Evaluations

Refer also to abstracts 20744, 21381, and 21724.

21420 (CEA-N-1266) DESORPTION IN NITROGEN OR IN HYDROGEN OF THE OXYGEN CHEMISORBED ON GRAPHITE. Le Bail, Henri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1970. 65p. (In French). (DPC-CPh-62/95). Dep. CFSTI (U. S. Sales Only).

The proportion of CO_2 in CO desorbed from graphite previously oxidized by air and heated to 900°C in a slow nitrogen current under atmospheric pressure decreases as the oxidation temperature (OT) increases. The desorption curve of CO and CO_2 shows a maximum around 600°C. The presence of a little amount of water in nitrogen slightly increases the reaction temperature. When H_2 is substituted by N_2, H_2O, CO_2 and CO are simultaneously produced. The amount of water desorbed is equal to that of CO_2 for natural graphites but increases for the porous artificial graphites when good industrial graphites are used instead of high purity graphites. Only one peak of CO, CO_2 and H_2O is observed for high purity graphites. In the case of industrial graphites, the desorption of water leads to three separated peaks at 400, 500, and 600°C. 600°C. The additional peaks result from the effects of impurities. The desorption of water in a hydrogen current is followed by a hydrogen chemisorption. Desorbed oxygen appears to be substituted by H_2 or 2H. (France)

21421 (JUL-605-RW) INFLUENCE OF THE STRUCTURE OF COATED FUEL PARTICLES ON THE DETERMINATION OF THE MODULUS OF ELASTICITY OF THE OUTER LAYER PERPENDICULAR TO THE SURFACE. Drittler, K. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Jul 1969. 27p. (In German). Dep. CFSTI (U. S. Sales Only).

For fuel element particles composed of layers with different physical properties, such as pyrocarbon-silicon carbide, a mathematical formula for determining the modulus of elasticity of the outer layer perpendicular to the surface was derived from pressure test data. Application of simple measuring equipment showed that, in particles containing an intermediate layer of silicon carbide, the composition of the inner layer must be taken into consideration. On the other hand, for particles which have a single external coating, the formulas for a solid sphere consisting entirely of the material of the outer face can be applied as a good approximation. (tr-auth)

21422 (ORNL-4507) HELIUM RELEASE FROM $^{238}PuO_2$ MICROSPHERES. Angelini, Peter; McHenry, R. E.; Scott, J. L.; Ernst, W. S. Jr.; Prados, J. W. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 27p. Dep. CFSTI.

The release of helium from plasma-melted $^{238}PuO_2$ microspheres was investigated under two experimental conditions: isothermal steady-state release at 100 to 1300°C and release during and following a transient-temperature rise from ambient to a constant final value ranging from 900 to 1900°C, with heatup time of 2 to 5 min. Release characteristics could be approximately described by diffusion models; however, different correlations of diffusion parameters were required for the two types of experiments. The transient-heating experimental results showed that helium release was complete above 1300°C within 10 min. (less at higher temperatures) and mechanical degradation of the microspheres was negligible. An explanation of the mechanism for the steady-state results is proposed. The mechanism of helium release under transient conditions is unclear, but appears to differ significantly from that at steady state. (auth)

21423 THE ENTHALPY OF URANIUM DIBORIDE FROM 600 to 1500°K BY DROP CALORIMETRY. Fredrickson, D. R.; Barnes, R. D.; Chasanov, M. G.; Nuttall, R. L.; Kleb, R.; Hubbard, W. N. (Argonne National Lab., Ill.). High Temp. Sci.; 1: 373-80(Oct 1969).

A high-precision drop calorimetric system was used to measure the enthalpy of uranium diboride in the temperature range 600 to 1500°K, relative to 298.15°K. The data obtained can be represented by the equation $(H_T^0 - H_{298.15}^0) = 19.0297T + 1.43535 \times 10^{-3}T^2 + 7.92523 \times 10^5T^{-1} - 8351.24$ cal/mole where T is temperature in degrees Kelvin. Values of C_p^0, $H_T^0 - H_{298}^0$, S^0, and $(F_T^0 - H_{298}^0)/T$ were calculated from the experimental data. A description is given of the calorimetric system, the main features of which are: a resistance-wire heated furnace; a copper-block calorimeter; and a drop mechanism. (auth)

21424 CRACKING IN OXIDES ON Zr ALLOYS. Moon, J. R.; Lees, D. G. (Imperial Metal Industries Ltd., Birmingham, Eng.). Corros. Sci.; 10: 85-9(Feb 1970).

Metallographic examination of thick adherent oxide films on Zr-1.0% Cu-1.5% Mo and Zr-2.5% Nb alloys after oxidation in steam at 400°C, 1500 psi, showed the presence of groups of cracks or cavities in the oxide. The groups were usually associated with the presence of a second phase, believed to be hydride, in the metal-oxide interface. Mechanisms for the formation of the groups of cracks are proposed, based on their association with the second phase. (auth) (UK)

21425 SELF-DIFFUSION ACTIVATION ENTHALPY OF INORGANIC SUBSTANCES WITH NaCl STRUCTURE. Oshcherin,

B. N. (Leningrad Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 147-50(1969). (In Russian).

Activation enthalpy of self-diffusion calculated from the characteristic temperature and melting point was tabulated for inorganic salts. The concepts of diffusion vacancy mechanism and self-diffusion activation was analyzed for inorganic salts with NaCl structure near the melting point. Carbon diffusion into carbides with similar structural vacancies was studied with various carbides, including ZrC and UC. (R.V.J.)

21426 PARAHYDROGEN CONVERSION STUDIES ON GADOLINIUM AND YTTRIUM AND THEIR OXIDES. Capozzi, Victor Frank. Alfred, N. Y.; State Univ. of New York (1969). 204p.

Thesis.

The parahydrogen conversion was studied on gadolinium and yttrium oxide powders and on gadolinium and yttrium metal films at 77 to 90°K and at 298 to 418°K over a pressure range of 2 to 10 torr. The extent of conversion was determined by use of a micro-Pirani gauge which makes use of the fact that the thermal conductivities of ortho- and parahydrogen are different, and that the relation between resistance of a filament surrounded by the gaseous reaction product and its parahydrogen content is linear. All surfaces were found to be active in catalyzing the conversion, and negative activation energies were found, indicating that the conversion proceeded by a physical mechanism in all cases. The conversion takes place by a predominantly vibrational mechanism on Gd_2O_3, and on Gd- and Y-metal. The rate of conversion on Y_2O_3 is enhanced above that expected for a simple vibrational mechanism, and it is suggested that this enhancement might arise from the presence of surface free valencies as is known to be the case for Al_2O_3. As is known to be the case of Gd_2O_3, evidence indicates that the conversion probably proceeds on two different types of sites on Y_2O_3. It appears that the conversion on the metals proceeds on one type of active site, the paramagnetic surface cation. A definite correlation was found between the activity of the metal and the corresponding oxide where the conversion is not enhanced by the presence of additional paramagnetic sites. (Diss. Abstr. Int., B)

21427 ELECTRICAL RESISTIVITY OF C.P.H. Zr–O ALLOYS. Giam, T. M.; Claisse, F. (Univ. Laval, Quebec). J. Nucl. Mater.; 34: 325-31(Mar 1970).

The electrical resistivities of dose-packed hexagonal Zr–O solid solutions were measured as a function of composition, temperature, and thermal treatment. Several anomalies were observed and attributed to ordered atomic arrangements at compositions Zr_6O, Zr_4O, Zr_3O, and $Zr_{24}O_{10}$. (auth)

21428 THE STRESS DEPENDENCE FOR HIGH TEMPERATURE CREEP OF POLYCRYSTALLINE URANIUM DIOXIDE. Seltzer, M. S.; Clauer, A. H.; Wilcox, B. A. (Battelle Memorial Inst., Columbus). J. Nucl. Mater.; 34: 351-3(Mar 1970).

A method is outlined which can be utilized to predict the stress at which the predominant high-temperature creep mechanism changes for polycrystalline, stoichiometric, high density UO_2. (G.M.C.)

21429 THE THERMAL DIFFUSIVITY, THERMAL CONDUCTIVITY, AND TRANSFORMATION TEMPERATURES OF CURIUM SESQUIOXIDE. Gibby, R. L.; McNeilly, C. E.; Chikalla, T. D. (Battelle Memorial Inst., Richland, Wash.). J. Nucl. Mater.; 34: 299-306(Mar 1970).

The thermal diffusivity of $^{244}Cm_2O_3$ (94% T.D.) was measured from 100 to 1450°C using a laser heat pulse apparatus. The results obeyed the empirical temperature relationship $\alpha = (0.0404T[°C] + 190)^{-1}$. Annealing of self-induced radiation damage was postulated to account for a sudden increase in thermal diffusivity observed during initial measurements. The thermal conductivity of Cm_2O_3, estimated from the thermal diffusivity data, was essentially independent of temperature varying between 0.015 to 0.016 W/cm · °C. The melting point of Cm_2O_3 was determined using a tungsten filament technique. Forty-five separate determinations gave a mean value of 2275 ± 25°C. Three solid-state phase transformations occurring at 1615, 2000, and 2210°C were identified in Cm_2O_3. (auth)

21430 EXPANDED PYROLYTIC GRAPHITE: STRUCTURAL AND TRANSPORT PROPERTIES. Olsen, L. C.; Seeman, S. E.; Scott, H. W. (McDonnell Douglas Astronautics Co., Richland, Wash.). Carbon; 8: 85-93(Feb 1970).

A process was developed for fabrication of a highly oriented expanded pyrolytic graphite (EPG). After forming a graphite bisulfate with pyrolytic graphite (PG), the material was heated to 500°C for several minutes to evolve acidic molecules and obtain expansion. X-ray analysis showed that the orientation density of two-fold and three-fold EPG is approximately the same as that for the parent material-PG heat treated at 3100°C. Describing the orientation density by $\cos^m\delta$, where δ is the polar angle of a crystallite with respect to the deposition plane; m-values of 300 to 600 are obtained. Transport properties are discussed. The thermal conductivity (K), electrical conductivity (Σ) and thermoelectric power (A) were measured in the ab- and c-directions, both as a function of expansion ratio and of temperature. K_{ab} was found to decrease from the values characteristic of pyrolytic graphite inversely with expansion ratio. K_c for two-fold and three-fold expanded material is ≃0.03 W/cm per °K. EPG transport properties are explained quite well by assuming a structural model consisting of a lamellar configuration involving two layers: one for which approximately 80% of the layer consists of PG and 20% void space; and the other composed of a low-density carbonaceous material which has literally been blown from the other type of layer. (auth) (UK)

21431 ON THE VALIDITY OF LENNARD–JONES POTENTIALS FOR THE CALCULATION OF ELASTIC PROPERTIES OF A GRAPHITE CRYSTAL. Kelly, B. T. (United Kingdom Atomic Energy Agency, Culcheth, Eng.).; Duff, M. J. Carbon; 8: 77-83(Feb 1970).

Calculations are made of C_{33}, C_{44}, $\partial C_{33}/\partial e_{zz}$, and the A-A stacking fault energy of a graphite crystal using Lennard–Jones potentials between atoms in different layer planes. An estimate is made of $\partial C_{44}/\partial e_{zz}$. The values of C_{33} and the A-A stacking fault energy are in fair agreement with experiment, but C_{44} is seriously underestimated and $\partial C_{33}/\partial e_{zz}$ is also underestimated. It is apparent that the Lennard–Jones potential is not adequate to represent the changes in energy for all relative movements of the layer planes of a graphite crystal. (auth) (UK)

21432 ELASTIC AND ANELASTIC RESPONSE IN A POLYCRYSTALLINE SYSTEM UO_2–PuO_2. Nutt, Alfred Walter Jr. Urbana, Ill.; Univ. of Illinois (1969). 151p.

Thesis.

The Förster resonance technique was used to investigate elastic and anelastic properties of mixed uranium–plutonium oxides. Young's and shear moduli were determined at room temperature from resonance frequencies. The bulk modulus and Poisson's ratio were derived from the calculated moduli. Observation of free decay of specimen amplitude at fundamental flexural resonance permitted calculation of internal friction. These measurements were made as a function of stoichiometry, density, and cation homogeneity. Within the scope of single phase solid solution, changes of oxygen to metal ratio had little effect upon the room temperature elastic moduli and internal friction of 80% UO_2–20% PuO_2 compositions. A maximum of about one percent change was observed in the Young's modulus and shear modulus as the (O/M) ratio was varied from 1.986 to 2.006. No significant change occurred in the damping capacity of 80% UO_2–20% PuO_2 single phase solid solutions as a function of oxygen to metal ratio. The room temperature elastic moduli of sintered hypostoichiometric 80% UO_2–20% PuO_2 solid solution increased with increasing density. A linear expression for this effect was given by $E = 2102.7(1 - 2.03P) \pm 13.5$ kilobars for the Young's modulus, $G = 823.5(1 - 2.05P) \pm 9.1$ kilobars for the shear modulus, and $B = 1584.8(1 - 1.89P) \pm 59.1$ kilobars for the bulk modulus, where "P" is the volume-fraction porosity. Poisson's ratio of $U_{0.8}Pu_{0.2}O_2$ was found to be 0.28 and was not a function of porosity. Specimen inhomogeneity had a pronounced effect upon the elastic moduli and internal friction of urania–plutonia composites. An approximate 24% decrease of the Young's and shear moduli and an approximate increase by a factor of fourteen in the internal friction were observed with gross modifications of plutonium cation heterogeneity. Whether these effects were caused entirely by the cation heterogeneity or by a complex combination of cation heterogeneity and consequential porosity was not established. (Disser. Abstr.)

21433 VACUUM THERMAL COMPRESSION OF POWDERS OF METALS AND REFRACTORY COMPOUNDS. Koval'chenko, M. S. pp 16.1-12 of Recent Material Developments in Powder Metallurgy. Vol. II. Dresden; Deutsche Akademie der Wissenschaften zu Berlin, Zentralinstitut fuer Festkoerperphysik und Werkstofforschung (1969). (In Russian).

From 4th International Meeting on Powder Metallurgy, Dresden, Ger. See CONF-690943-(Vol.2).

The basic theory and analysis of various experimental data on thermal compression of powders of refractory metals and compounds in a vacuum or gaseous media were examined. (R.V.J.)

Structure and Phase Studies

21434 (MLM-1690) A HIGH-TEMPERATURE X-RAY STUDY OF $^{238}PuO_2$ PLASMA-FORMED MICROSPHERES.

DeSando, R. J.; Wyder, W. C.; Eckstein, R. R.; Amos, W. R. (Mound Lab., Miamisburg, Ohio). 20 Mar 1970. Contract AT(33-1)-Gen-53. 11p. Dep. CFSTI.

A high-temperature x-ray study of $^{238}PuO_2$ microspheres (50 to 250 μm in diameter) produced from an rf induction-coupled plasma torch has been conducted in the temperature interval of 14 to 1505°C. The lattice parameters obtained at 22 different temperatures exhibit linearity up to about 675°C and expand in a normal fashion up to 1137°C. The expansion curve undergoes anomalous behavior at 1137°C, which is attributed to a major fraction of helium (produced from alpha emission) being released and removed of configurational defects by annealing. The lattice parameters of the $^{238}PuO_2$ microspheres are slightly larger than the parameters of $^{238}PuO_2$ powder because of radiation damage and helium entrapment. Fourth-degree polynomial expressions as functions of temperature for the lattice parameter (a), instantaneous coefficient of thermal expansion (α_1), and fractional changes in the lattice parameter ($\Delta a/a$) are presented. Mean square atomic vibrational amplitudes were computed from the thermal expansion data using Grüneisen's theory, and exhibit an increase with temperature as expected. The root-mean-square vibrational amplitudes, $\langle u^2 \rangle_{av}^{\frac{1}{2}}$, at 50 and 1137°C are 0.037 and 0.20 Å, respectively. (auth)

21435 (NUMEC-3292-14) THE VERIFICATION OF ELEMENTAL BORON CRYSTALLINITY BY X-RAY DIFFRACTION. Marano, R. T.; Shuster, E. R. (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). 18 Dec 1969. Contract AT(40-1)-3292. 9p. Dep. CFSTI.

A diffractometer procedure for determining crystallinity of elemental boron has been developed. It is recommended as an alternate or replacement for the x-ray diffraction camera technique required by the specification for this material. (auth)

21436 PHASE INVESTIGATION OF THE YTTERBIUM-CARBON SYSTEM. Haschke, John M.; Eick, Harry A. (Michigan State Univ., East Lansing). J. Amer. Chem. Soc.; 92: 1526-30(25 Mar 1970).

The ytterbium–carbon system, YbC_x, was investigated over the composition range $0.33 \leq x \leq 2.00$; samples were prepared by direct reaction of the elements in sealed tantalum bombs. Four phases were identified by x-ray diffraction and elemental analysis: tetragonal $YbC_{2.00}$ ($a = 3.639 \pm 0.003$, $c = 6.110 \pm 0.008$ Å), monoclinic $YbC_{1.25+y}$ with $0 \leq y \leq 0.16$ ($a = 7.070 \pm 0.005$, $b = 7.850 \pm 0.004$, $c = 5.623 \pm 0.005$ Å, $\beta = 90.99 \pm 0.09°$, for samples quenched from 1450°K), $YbC_{0.95}$, and dimorphic $YbC_{0.50\pm x}$ (fcc, $a = 5.001 \pm 0.003$ Å and rhombohedral, $a = 6.167$ Å, $\alpha = 33.33°$). A linear variation of both the carbon-rich $YbC_{1.25+y}$ phase boundary and the monoclinic b parameter with temperature was observed. A partial phase diagram for the Yb–C system is proposed, and the variation of composition and lattice parameter of the $YbC_{1.25+y}$ phase is discussed. (auth)

21437 STRUCTURAL CHARACTERISTICS OF CUBIC ZrO_2 STABILIZED BY CALCIUM. Filatov, S. K.; Frank-Kamenetskii, V. A. (Leningrad State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); Transl.); 14: 414-5(Nov-Dec 1969).

Translated from Kristallografiya; 14: 505-6(May-Jun 1969).

After a description of possible models for Zr–Ca substitution in fluorite-cubic ZrO_2, an attempt was made to differentiate the structural variants, using more exact intensity measurements in x-ray diffraction on ZrO_2 with 12 mole % CaO. Experimental structure-amplitudes are compared with calculated values; the discrepancy factor is smallest for Zr–Ca substitution at equivalent structural sites, with generation of oxygen vacancies. (D.L.C.)

21438 NONSTOICHIOMETRY IN THE $ZrSe_2$ PHASE. Gleizes, A.; Jeannin, Y. (CNRS, Toulouse). J. Solid State Chem.; 1: 180-4(Jan 1970).

Nonstoichiometric $ZrSe_2$ phase characterized by a C6 structure type has been studied on compounds prepared at 800° by direct synthesis. The limits of the homogeneous phase, determined from lattice constant measurements, are related to Se/Zr = 1.850 and Se/Zr = 1.945 atomic ratios. For the highest selenium content, the crystal contains selenium vacancies. As Se/Zr decreases, zirconium additional atoms occupy these vacancies. When they are all filled up, the lowest selenium limit is reached. Lattice constant variations are interpreted through this model. (auth)

21439 CRYSTAL STRUCTURE OF THE φ PHASE IN THE BORON-SODIUM SYSTEM. Naslain, Roger; Kasper, John S. (General Electric Research and Development Center, Schenectady, N. Y.). J. Solid State Chem.; 1: 150-1(Jan 1970).

The crystal structure of a complex boride, NaB_{15}, has been determined by x-ray diffraction methods using single crystals. The structure consists principally of B_{12} icosahedra arranged in a novel way but with additional boron atoms linking icosahedra together. The sodium atoms occur in large cages that result from the boron arrangement. (auth)

21440 CRYSTALLOGRAPHIC AND MAGNETIC ORDERING STUDIES OF PLUTONIUM CARBIDES USING NEUTRON DIFFRACTION. Green, J. L.; Arnold, G. P.; Leary, J. A.; Nereson, N. G. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater.; 34: 281-9(Mar 1970).

Neutron diffraction studies were carried out on polycrystalline samples of carbon-saturated PuC_{1-x} and Pu_2C_3. In both, the targets were prepared from material that was highly enriched in ^{240}Pu to minimize the fast neutron background due to the thermal fission of ^{239}Pu. A magnetic transition was observed to occur in PuC_{1-x} at approximately 100°K. The ordered structure was found to be composed of ferromagnetic layers coupled antiferromagnetically. The planes of constant spin are the (001) planes and the spin vectors are aligned perpendicular to the (001) planes. No low temperature magnetic ordering was observed in Pu_2C_3. Room temperature diffraction data were used to compute the crystal positional parameters for this compound: $X_C = 0.2896 \pm 0.0005$, $X_{Pu} = 0.0492 \pm 0.0005$, and the thermal parameter: $B = 0.69 \pm 0.06$ Å^2. The C–C bond length calculated from these data was 1.39 Å. Using room temperature data for both compounds, the coherent scattering amplitude of pure ^{240}Pu was found to be 0.38×10^{-12} cm. (auth)

21441 THERMOGRAVIMETRIC STUDY OF THE COMPOSITION OF FUSED VANADIUM PENTOXIDE AS A FUNCTION OF THE TEMPERATURE AND OF THE OXYGEN PRESSURE. Desagher, Serge; Yu, Liang-tse; Buvet, Rene (Paris Univ. Ecole Superieure de Physique et de Chimie Industrielles, Paris). Compt. Rend., Ser. C.; 270: 465-8(2 Feb 1970). (In French).

Samples of fused vanadium pentoxides studied by thermogravimetry were found to be stoichiometric at 700°C (melting point) in the presence of pure oxygen. The compound becomes substoichiometric as temperature increases or as oxygen presence decreases. The oxygen losses at equilibrium (as a function of temperature and oxygen pressure) are given in the temperature range 700 to 900°C and in the oxygen pressure range 1 to 10^{-3} bar. (auth) (France)

Radiation Effects

Refer also to abstracts 21736 and 22431.

21442 (BARC-436) IN-REACTOR ELECTRICAL RESISTIVITY MEASUREMENTS ON THORIUM DIOXIDE. George, A. M.; Karkhanavala, M. D.; Harvey, A. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 9p. Dep. CFSTI (U. S. Sales Only).

An experimental setup to study the resistivity changes of thorium oxide during reactor irradiation is described. The assembly, located at the CIRUS, permits irradiation of the samples in a range of neutron fluxes. Thermoelectric power measurements can also be made on semiconducting ceramics ($\rho \sim 10^9$ Ω-cm) having fairly high Seebeck coefficients. Results of some preliminary experiments carried out on sintered thorium oxide and thorium oxide doped with 2 mole % calcium oxide are presented. (auth)

21443 (BMI-1878, Sect.C) CREEP OF REACTOR FUEL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 26p.

A program to study the elevated-temperature creep behavior of fuels of interest for liquid-metal fast breeder reactors (LMFBR) is described. Major emphasis is on UO_2-PuO_2 fuels, although initial experiments are being conducted on UO_2. In-pile creep experiments will determine the mechanical behavior of fuel under actual irradiation conditions. The information to be obtained is of importance for predicting fuel swelling behavior. Preirradiation creep experiments are being performed to determine to what extent out-of-pile behavior can be used to predict in-pile behavior, and to help provide information on basic creep mechanisms which can be used in the design of fuels of increased creep strength. (auth)

21444 (EURAEC-2135) IRRADIATIONS OF HIGH BURN-UP UO_2-PuO_2 CERAMIC FUELS. Final 2, Part Final. Special Technical Report BN-6911-01. Lhost, A.; van Outryve d'Ydewalle, B. (Societe Belge pour l'Industrie Nucleaire, Brussels). Nov 1969. 47p. Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The irradiation of two PuO_2-enriched UO_2 fuel rods in an instrumented device is described. The rods were subjected, in the BR-2 (Mol-Belgium), to neutron fluxes such that the peak thermal power was estimated at 400 W/cm and the burnup at 20,000 MWd/t. Irradiation results are comparable to those obtained earlier in similar irradiation. (auth)

21445 (GEAP-10121) ZIRCALOY-CLAD UO_2 FUEL ROD EVALUATION PROGRAM. Quarterly Progress Report No. 8, August-October 1969. Megerth, F. H. (comp.) (General Electric Co., San Jose, Calif. Reactor Fuels and Reprocessing Dept.). Nov 1969. Contract AT(04-3)-189. 19p. Dep. CFSTI.

The irradiation of Assembly SA-1 was terminated in September 1969, after 1800 days of VBWR and Dresden operation. The final bundle average exposure of the SA-1 fuel rods is approximately 8×10^{20} fissions/cm^3 (30,000 MWd/t U). Post-irradiation leak testing of the assembly indicated that it is sound. A number of high-temperature tensile tests were run on longitudinal coupon cladding specimens in which the specimens were held at the test temperatures for periods longer than the normal 15-minute soaking time before tension was applied. Holding specimens at 343°C for up to 16½ hours had no significant effect on any of the 343°C tensile properties. However, a specimen held for 16½ hours at 399°C showed ultimate and yield strengths approximately 950 kg/cm^2 and 1200 kg/cm^2 lower than any specimen tested at 399°C by the normal procedure, and, in addition, it showed somewhat greater uniform and total elongations. The 454°C tensile properties of the irradiated cladding apparently were not affected significantly by increasing the soaking time to 1 hour at that temperature. The ultimate strengths of three irradiated specimens held at 454°C for 16½ hours before testing approached that of the unirradiated material. These same specimens showed wide variations in elongation. The atom ratios of ^{243}Am to ^{239}U ranged from 0.41×10^{-4} to 0.56×10^{-4} in full-cross-section fuel samples with exposures from 6.9×10^{20} to 7.8×10^{20} fissions/cm^3 (25,300 to 28,500 MWd/t U). The $^{243}Am/^{239}U$ ratios at pellet surfaces were determined to be approximately three times the $^{243}Am/^{239}U$ ratios at corresponding pellet centers. (auth)

21446 (WAPD-TM-940) COMPARISON OF DIMENSIONAL CHANGES IN FUEL RODS WITH PREDICTIONS UNDER CYCLIC CONDITIONS OF POWER AND SYSTEM PRESSURE (LWBR DEVELOPMENT PROGRAM). Duncombe, E.; Goldberg, I. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar 1970. Contract AT(11-1)-Gen-14. 24p. Dep. CFSTI.

The various additions to the CYGRO fuel rod analysis technique in order to calculate ratchetting effects are described. These effects include fuel cracking, clad collapse, friction between fuel and clad, clad anisotropy, and effects of neutron flux on clad creep. By reasonable choice of parameters good agreement can be obtained with tests on axial elongations of non-free-standing fuel rods. There is a pronounced sensitivity of these predictions to the value of creep enhancement as a result of neutron flux. Predictions of diameter changes are believed to be inherently less accurate because of the masking effects of ridging, wrinkling, and clad collapse. (auth)

21447 A TECHNIQUE FOR MEASURING GAS PRESSURE INSIDE COATED PARTICLE FUELS. Horsley, G. W.; Sheldon, B. E.; Rose, K. S. B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 34: 345-7(Mar 1970).

A simple method of measuring gas pressures in coated particle fuels by using a balancing fluid pressure technique is described. The method was tested by measuring helium gas pressures produced from the thermal-neutron-irradiated ^{10}B isotope in silicon-carbide-coated boron carbide kernels. (G.M.C.)

Plastics and Other Materials

21448 (ORNL-4521) SHATTERPROOF COATINGS FOR GLASS. Gray, R. J. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The shatterproofing of glass with Silastic coatings, which can be applied in the laboratory, has been investigated. The items tested were light bulbs, Pyrex tubing, Dewar flasks, and capillary tubes. Two commercial products definitely improved the impact resistance of the glass and greatly reduced shattering of the sharp particles. Investigation results can be used in minimization of the hazard of glass containers used in glove boxes. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

21449 ASTROPHYSICS AND GENERAL RELATIVITY. VOLUME 1. Chretien, M.; Deser, S.; Goldstein, J. (eds.). Brandeis University Summer Institute in Theoretical Physics, 1968. New York; Gordon and Breach, Science Publishers, Inc. (1969). 308p. $17.50.

The Eleventh Brandeis Summer Institute in Theoretical Physics was held between June 17 and July 26, 1968. Four lectures were presented on statistical mechanics of stellar systems, the physics of the interstellar and intergalactic medium, gravitational collapse, and extragalactic radio astronomy. Separate abstracts were prepared for the four lectures. (W.D.M.)

For abstracts of individual sections see: 21479, 21505, 21506, and 21511.

21450 STABILITY OF CERTAIN TYPES OF FORCE-FREE PERIODIC FIELDS. Raghavachar, M. R. (Indian Inst. of Science, Bangalore). Proc. Nat. Inst. Sci. India, Part A; 35: 731-9(Sep 1969).

The stability of a certain type of periodic force-free fields having neutral lines, investigated by Schatzman on the basis of the energy principle, is discussed. The normal-mode technique is employed, restricted to the neighborhood of neutral lines. The neutral lines contribute to instability, in agreement with Schatzman. Repetition of stability analysis employing the energy principle revealed that every cell appears to be stable, contrary to Schatzman's conclusion that instabilities can be present under certain conditions. Moreover, this study provides the growth rate of the instabilities. (auth)

Cosmic Ray Exposure Ages

Refer also to abstract 20737.

Stars

Refer also to abstract 21794.

21451 (UCRL-Trans-10439) EMERGENCE OF A SHOCK WAVE INTO AN EXTENDED ENVELOPE OF A STAR AND SUPERNOVA EXPLOSIONS. Grasberg, E. K.; Nadezhin, D. K. (Akademiya Nauk SSSR, Moscow. Institut Prikladnoi Matematiki). Translated by A. M. A. Mincer for Univ. of California, Lawrence Radiation Lab., Livermore, from Russian Preprint No. 21. 29p. Dep. CFSTI.

The emergence of a strong shock wave into the atmosphere of a supergiant star having a radius of 5000 to 10,000 $R_\odot$ is calculated on the basis of hydrodynamic equations in the radiative heat conductivity approximation. The results suggest that the light curves of type II supernovae near the maximum can be explained by a thermal mechanism. For this purpose the star must have prior to the explosion an extended atmosphere, which may be due to a transition to the supergiant evolutionary stage or to slow outflow of substance in the pre-supernova stage. The calculations also indicate that the light curves of type I supernovae up to the section of exponential decrease in luminosity can be explained by effects in an extended atmosphere. The important role played by radiative heat conductivity leads to heating of the atmosphere by a strong thermal wave propagating before the viscosity jump and to the formation of a luminosity maximum before the emergence of the shock wave on the surface. Escape of energy by radiation from the shock front leads to sweeping of the atmospheric matter and to its ejection in the form of a thin, dense shell. (auth)

21452 EXACT ANALYTIC SOLUTION FOR EXPLOSION WAVES IN STELLAR INTERIORS. Deb Ray, G. (St. Xavier's Coll., Calcutta). Proc. Nat. Inst. Sci. India, Part A, Suppl.; 35: No. 2, 182-94(Jul 1969).

An exact solution for propagation of explosion waves in stellar models was obtained. The disturbance is headed by a shock surface of variable strength. The total energy of the wave also varies with time. Constancy of total energy, however, follows as a particular case. (auth)

21453 NEUTRAL-HELIUM LINE STRENGTHS. II. THE B-TYPE SUBDWARF HD 205805. Baschek, Bodo; Norris, John (Australian National Univ., Canberra). Astrophys. J., Suppl. Ser.; 19: No. 176, 327-36(Mar 1970).

Spectra and continuum colors have been obtained for the B-type subdwarf HD 205805. On the assumption of LTE, an analysis of the helium line strengths leads to the conclusion that the atmospheric-helium abundance of HD 205805 is smaller by a factor of 10 than that of the Population I star γ Peg. The helium singlet-triplet anomaly is explained by both the higher gravity and the lower helium abundance of the subdwarf. There is no evidence for departures from LTE. An analysis, using the data of Sargent and Searle, of three other sdB stars, Feige 11, 36, and 65, shows that the helium deficiency is a common property of these stars. Compared with HD 205805, Feige 11 and 65 are deficient by a factor of 4. Feige 36 has an abundance similar to that of HD 205805. (auth)

21454 NEUTRAL-HELIUM LINE STRENGTHS. III. THE SINGLET-TRIPLET ANOMALY OF POPULATION I STARS. Norris, John (Australian National Univ., Canberra). Astrophys. J., Suppl. Ser.; 19: No. 176, 337-41(Mar 1970).

The singlet-triplet anomaly of main-sequence Population I stars is explained within the framework of LTE. (auth)

21455 EXPLANATION FOR THE BROAD SUPERNOVA BANDS. Huffman, D. R. (Univ. of Arizona, Tucson). Nature (London); 225: 833-4(28 Feb 1970).

It is stated that spectra of type I supernovae show broad emission bands that have not been satisfactorily explained. It has been suggested (Seddon, Nature, 222: 757(1969)) that the structure in the visible spectrum be regarded as broad absorption bands on a more intense continuum. The absorption bands could be produced by clouds of dust surrounding the star, and on this supposition several supernovae absorption features fall near some of the much narrower unidentified absorption bands arising in the interstellar medium. An application of this interstellar band explanation to supernovae spectra, interpreted in terms of absorption features, is discussed. The explanation offered for the most intense interstellar bands is that they are due to iron ions in crystal such as garnet silicates. Because of the strong electric fields of neighbouring O^{2-} ions in the crystal the absorption bands due to iron ions are very different from those of free iron ions. At low crystal temperatures bands with widths of about 30 Å can occur, while at room temperature and above bandwidths are typically several hundred Å. The iron ions can occupy three different positive ion sites, giving rise to several different crystal field bands in each site. In all garnet crystals there is a rising absorption in the uv, with shape and position depending on the exact chemical composition, and if the absorption bands in supernovae spectra are due to surrounding clouds of such dust the uv intensity transmitted through the dust should be very low. A suggestion of such an effect may be seen in the decrease of the short wavelength intensities as the absorption bands of the supernova increase with time. Bands due to iron ions in garnets taken from optical absorption measurements of the supernova in NGC 4496 are shown, together with the spectrum of almandine garnet. It is seen that seven bands due to iron ions correlate in wavelength and approximate width; these bands are centered at about 6100, 5700, 5100, 4900, 4100, and 3800 Å. A rough estimate is made of the amount of garnet dust necessary to produce the observed bands, obtained by using the absorption coefficients of almandine. Several important facts concerning supernovae are implied: (1) the widths of the features in the supernovae spectra are due chiefly to inherent broadness of the optical absorption bands in the solids, and the large widths should not be associated with large velocities; (2) the measured blue and uv intensities that reach the Earth may bear little resemblance to the initial intensities; (3) the supernova dust cloud that gives rise to the broad absorption bands, when cooled to the low temperature of interstellar dust, could give rise to a number of the much narrower bands observed to arise in the interstellar medium. (UK)

21456 THE RELATIVISTIC ELECTRON SPECTRUM IN PLANETARY NEBULAE WITH NONTHERMAL RADIOEMISSION. Oganesyan, Dzh. B. (Cosmic Research Inst., Erevan). Dokl. Akad. Nauk Arm. SSR; 46: 176-7(1968). (In Russian).

According to previous data, the radioemission of at least 5 planetary nebulae exhibit a different spectral index than thermal radio emission; these emissions have a thermal and a nonthermal component. From the measured intensity of the radio emission it was possible to calculate a corrected distribution. It was found that the nonthermal emission of planetary nebulae differs strongly from similar emissions of other known sources. If it is assumed that this nonthermal emission has a synchrotron origin, it may be concluded that relativistic electrons are generated and exist under different conditions in planetary nebulae than in the usual nonthermal radiation sources. (TTT)

21457 NEUTRAL-HELIUM LINE STRENGTHS. I. LINE PROFILES FOR A GRID OF APPROXIMATE LINE-BLANKETED

MODEL ATMOSPHERES. Norris, John; Baschek, Bodo (Australian National Univ., Canberra). Astrophys. J., Suppl. Ser.; 19: No. 176, 305-26(Mar 1970).

Line profiles of neutral helium are presented for a grid of approximate line-blanketed model atmospheres. The isolated lines are computed with the line-broadening theory of Griem, Baranger, Kolb, and Oertel. The wings (long-wavelength halves) of the strong lines of the 2P–nD series are obtained from the quasi-static theory of Pfennig and Trefftz; the cores are computed from an adiabatic-impact treatment following Traving. (auth)

21458 STUDY OF STARS EXHIBITING COMPOSITE SPECTRA. Markowitz, Allan Henry. Columbus, Ohio; Ohio State Univ. (1969). 97p.

Thesis.

MK spectral types and rotational velocities were estimated for both components of all known composite stars brighter than visual magnitude 7.0 and north of −25° declination; some 74 systems. In addition, artificial composite spectra of the main spectral-type combinations were constructed with varying Δm between the components and these were used to estimate Δm between the components of the program stars. The change in the artificial composite spectra with changing Δm is displayed and discussed. The results show that the spectra of composite stars typically consist of a G-type giant combined with an early A-type dwarf. This is shown to be largely the result of selection effects which are such that there are estimated to be at least four times as many composites brighter than seventh magnitude than are presently known. The mean rotational velocities of the early-type components are found to be substantially less than the means for the corresponding MK types among wide visual binaries and field stars. A significant number of composite components are found to lie in the Hertzsprung gap of the H–R diagram. It is suggested that the closeness of the components may have affected their evolution and the slow rotation of the early-type components may be a further reflection of this. (Diss. Abstr.)

21459 THE LUMINOSITIES AND THE SPATIAL DISTRIBUTION OF STARS DETECTED ON A TWO-MICRON SKY SURVEY. Hughes, Evan Eugene Jr. Pasadena, Calif.; California Inst. of Tech. (1969). 207p.

Thesis.

An infrared sky survey, carried out at the California Institute of Technology, has resulted in a catalog of the 5612 sources whose flux at 2.2μ was measured to be greater than 2.5×10^{-15} watts $cm^{-2}\mu^{-1}$. (Neugebauer, G., and Leighton, R. N., Two Micron Sky Survey, A Preliminary Catalog, National Aeronautics and Space Administration, Washington, D. C., 1969.) The positions and the fluxes at 2.2 and 0.8μ of the stars in the catalog are taken here as the input data for a determination of the luminosities and the distribution in space of these stars. The 0.8μ measurements are used only for the purpose of dividing the catalog stars into four groups on the basis of the ratio of 2.2μ flux to 0.8μ flux. (TSS) (Diss. Abstr.)

21460 DEPARTURES FROM LTE FOR NEUTRAL HELIUM LINES IN HOT STARS. Poland, Arthur Ira. Bloomington, Ind.; Indiana Univ. (1969). 156p.

Thesis.

Although the weakening of the singlet lines of neutral helium relative to the corresponding triplets along the spectral sequence in both directions from B3 has been known for many years, the explanation of the phenomenon is still uncertain. To assess the importance of departures from thermodynamic equilibrium among the populations of the bound states of He I in explaining the observations, calculations were made of departures for several model helium atoms, including some with levels through n = 20, in model atmospheres of 20,000 K, 30,000 K, and 40,000 K. The coupled equations of radiative transfer and steady state were solved for all significant bound–bound transitions and for all bound–free continua. (TSS) (Diss. Abstr. Int. B.)

21461 BIRTH OF STARS. De Closets, Francois. Sci. Avenir; No. 273, 872-9; 948(Nov. 1969). (In French).

General problems of the identification of classes of stars and of their ages are first reviewed, and recent developments in the identification and analysis of the behavior of very young stars are described. The observations of R Monocerotis and the hypothesis of its inclusion in a cloud of dust to explain the strong infrared emission suggest the formation of a planetary system in a very early stage. Thus, planetary systems are not exceptional, as the recent observation of Van de Kamp on Barnard's star must suggest. Stars forming from interstellar dust are found in precise regions of the Galaxy. Recent radioastronomical study of compact H II regions suggests that these compact regions are small; thus the clouds are not uniform, and the increased density may or may not be, at the moment, correlated with the formation of a star. This suggests that there may be multiple formations of protostars within clouds, and correlation, perhaps, with the pump for OH emission, which also comes from narrowly defined sources. Problems of nonuniformity within the cloud, and the question of the time scale for these processes, are not understood. (BBB)

21462 THE NATURE OF LOW-MASS COMPANIONS OF STARS IN THE SOLAR NEIGHBORHOOD. Kumar, Shiv S. (Univ. of Virginia, Charlottesville). Ann. N. Y. Acad. Sci.; 163: 94-7(4 Sep 1969).

The problem of the evolution of stars of very low mass is reviewed, and observational data on the stars of very low mass and the low-mass companions of stars of very low mass in the solar neighborhood are discussed. An interpretation is given of the observed data on low-mass companions, and some general remarks offered on the question of the existence of planetary systems in the Galaxy. The end product of the evolution of a star of very low mass is a completely degenerate object. The material cannot be compressed any further after the star has become completely degenerate, and the contraction comes to a stop at a certain limiting radius. It takes less than one billion yr for a star of very low mass to become an intrinsically faint, red object. Two faint, red stars that have masses less than the limiting mass are known. The visual binary system L726-8 has two components, each component having a mass $\simeq 0.04\ M_{\odot}$. The contraction time scale for both of these stars is 5×10^8 yr and these stars must already be degenerate. When a star of a very low mass becomes a black dwarf, it can be observed only if it is moving around another visible star. Stars that possess black-dwarf companions are tabulated. The orbits of known black dwarfs around the visible K and M main-sequence stars are highly eccentric. Further, the mass ratios of the primary (visible) star to the secondary (black dwarf) is in the range 10 to 50. The eccentricities and mass ratios are thus characteristic of the double (or multiple) stars. It is suggested that a large fraction of the so-called single late-type dwarfs is accompanied by black-dwarf companions. (BBB)

21463 SOME SPECIAL CASES OF SPHERICALLY SYMMETRIC GRAVITATIONAL COLLAPSE WITH REFERENCE TO NEUTRINO EMISSION. Singh, K. P.; Srivastava, M. C. (Banaras Hindu Univ., India). Proc. Nat. Inst. Sci. India, Part A; 35: 619-28(Sep 1969).

Misner's field equations (1965) for spherically symmetric gravitational collapse with escaping neutrinos are considered for some particular cases. It is shown that spherically symmetric gravitational collapse with neutrino emission is not possible if the congruence associated with the matter field satisfies any two of the following properties: (i) it is geodetic, (ii) it is expansion-free, and (iii) it is shear-free. Also, the field does not permit neutrino emission if the null congruence associated with neutrino emission is expansion-free. A case is worked out with geodetic matter congruence where the possibility of neutrino emission is demonstrated. Similarly it is shown that neutrino emission is possible in the case of shear-free matter congruence. (auth)

21464 ESCAPE OF PHOTONS FROM A ROTATING STAR. Misra, R. M.; Narain, Udit (Univ. of Gorakhpur, India). Proc. Nat. Inst. Sci. India, Part A; 35: 653-8(Sep 1969).

The motion of light rays in the stationary gravitational field of a rotating star is discussed. It is shown that rotation drastically modifies the behavior of the ray. However, for stars with small angular velocity, the escape of ray is similar to a nonrotating case. (auth)

21465 RADIAL OSCILLATIONS OF COMPOSITE POLYTROPES. PART II. Singh, Manmohan (Univ. of Roorkee, India). Proc. Nat. Inst. Sci. India, Part A; 35: 703-8(Sep 1969).

Small radial oscillations of four composite polytropic models with interfaces $\xi_1 = 0.2094$, 0.3915, 0.6160, and 0.8250, having indices 1.5 in the core and 3 in the envelope, are considered. The anharmonic pulsations of these models are discussed. (auth)

21466 ON THE NATURE OF S VULPECULAE. Fernie, J. D. (David Dunlap Observatory, Richmond Hill, Ont.). Astron. J.; 75: 244-5(Apr 1970).

UBV observations of S Vul are presented. On the basis of all the available evidence it is concluded that Wachmann's suggestion that S Vul is a classical Cepheid is most likely correct. In this case it is the Cepheid of longest period known in the Galaxy. Basic data for the star are determined. (auth)

21467 RADIAL VELOCITIES OF FIELD HORIZONTAL-BRANCH STARS. II. 1 HLF 2. Philip, A. G. Davis (State Univ. of New York, Albany). Astron. J.; 75: 246(Apr 1970).

A table is presented giving the radial velocities of six horizontal-branch stars in the 1 HLF 2 area. Their velocity dispersion is

±109 km/sec, confirming their assignment to membership in Population II. (auth)

21468 PULSATION AND THE RADIUS OF THE SOUTHERN CEPHEID S NOR. Breger, Michel (State Univ. of New York, Stony Brook). Astron. J.; 75: 239-43(Apr 1970).

New velocity and light measurements of S Nor in the galactic cluster NGC 6087 are reported. The velocity curve including the secondary hump is very similar to that of β Dor, another 10-d Cepheid. An analysis of all the light data does not support a previous suggestion of an increasing period. A constant period of 9.7542d is derived. The radius is calculated by several methods including the Wesselink cluster modulus and Christy's "bump" method. The Wesselink method fails to predict self-consistent radii for S Nor, but other methods suggest a mean radius of 60 $R_\odot$ with an uncertainty of about 10%. When the theoretical "bump" method was applied to other Cepheids, it also predicted radii 20% smaller than the Wesselink radii. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

21469 ENERGY SPECTRUM AND THE ABSOLUTE FLUX OF VARIOUS CELESTIAL X-RAY SOURCES. Rao, U. R.; Chitnis, E. V.; Prakasarao, A. S.; Jayanthi, U. B. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A; 70: 257-74(Dec 1969).

The results on the flux of low-energy x rays in the range 2 to 18 keV from Sco-X1, Tau-X1, and Cen-X2 celestial sources observed during two rocket flights, flown from the Thumba Equatorial Rocket Launching Station, Trivandrum, India, are presented. The absolute flux and the energy spectrum obtained for these sources are compared with other similar observations. The results indicate a long-term exponential decrease in the energy flux of x rays from Sco-X1 over the period 1965–1968. The x-ray source Cen-X2, which showed a remarkable outburst of x rays in April 1967, had ceased to be active after May 1967. The first evidence is presented of the rediscovery of the low energy, x-ray flux from Cen-X2 since May 1967. These short-lived x-ray outbursts may be attributed to a shock wave from the nova outburst expanding into the circumstellar medium. (auth)

21470 PULSARS AND THE UNIVERSAL X-RAY BACKGROUND. Apparao, M. V. K. (Tata Inst. of Fundamental Research, Bombay). Nature (London); 225: 836-7(28 Feb 1970).

It has been established that there is a universal x-ray background with an energy flux of about 10^{-7} erg cm^{-2} sr^{-1} s^{-1}. Previous possible explanations for this background are briefly discussed, and the suggestion is made that the x-ray background arises as a superposition of sources that are nascent pulsars in various galaxies. In this connection the pulsar NP 0532 in the Crab Nebula, the strongest pulsar so far observed, is considered. The x-ray energy output from MP 0532 is about 10^{36} ergs/sec, the optical output is about 10^{34} ergs/sec, and the radio radiation is a few times 10^{31} ergs/sec. The total energy dissipation is estimated as 2 to 4×10^{37} ergs/sec. Thus the x-ray emission is 2 to 5% of the total energy dissipation. A newborn pulsar is estimated to have a rotational energy content of 10^{52} ergs. An expression is given for the x-ray background intensity from the superposition of galaxies, and it appears that the universal background could arise as a superposition of radiation from pulsars in various galaxies. In this connection it is important that the superposition of the radio radiation from these pulsars should not be larger than the observed extragalactic radio radiation. This is possible if the pulsar radiation is less than the x radiation by a factor of 10^4, and this is true for NP 0532 and even more likely to hold in the earlier life of a pulsar, when the magnetic fields are higher. The x-ray energy spectrum due to the superposition cannot be predicted, since it would involve assumptions on the energy spectrum of pulsars during their early life—but as the radiation escapes from the pulsars into intergalactic space absorptive effects caused by gas within the galaxies should leave an impression on the spectrum. (UK)

21471 SECONDARY PERIODICITIES IN PULSARS. Hesse, K. H. (Cavendish Lab., Cambridge, Eng.). Nature (London); 225: 837-8(28 Feb 1970).

Periodic intensity fluctuations in pulsars are supported by the data obtained in measurements on five pulsars (CP 0808, 0834, 0950, 1133, and 1919), using the 4-acre, 81.5-MHz phased array at the Mullard Radio Astronomy Observatory. The data also reveal a very pronounced modulation for CP 0834, which cannot be explained readily by current theories, and also give an upper limit for the stability of the secondary periodicity in the case of CP 1919. The power spectra of the pulse-to-pulse intensity variations for the five pulsars are shown, together with a record of CP 0834 showing alternate pulses, and a summary is given of the power spectra data for these pulsars, including frequency of second periodicity and percentage modulation. Results are discussed for all five pulsars. CP 0834 and 1919 show prominent spectral components corresponding to modulation periods of 2.16 and 4.39 times the pulse period, respectively. The spectrum of CP 1919 shows a clear feature at 0.167 ± 0.008 Hz which is only partially obscured by the effects of the large random pulse-to-pulse variations found in this source, but it is possible that this modulation is not a constant feature of this source. The results for CP 0834 are particularly interesting because of the very strong modulation effect observed; at 81.5 MHz the percentage modulation is rarely less than 33% and may approach 100%. The pronounced character of the amplitude variations at this frequency is consistent with the reported frequency dependence. It was important to investigate the constancy of the observed secondary periodicities, and in order to look for long-term changes a power spectrum analysis of CP 1919 was carried out using data obtained in Dec. 1967. An upper limit of 5% for change in period over 1.4 yr was deduced. The origin of the secondary periodicities is stated to be uncertain; for CP 0834, at least, some mechanism apart from sub pulse structure appears to be necessary. (UK)

21472 PULSAR WOBBLE AND NEUTRON STARQUAKES. Ruderman, M. (Columbia Univ., New York). Nature (London); 225: 838-9(28 Feb 1970).

It is stated that two types of nonsecular charges in pulsar frequency (f) have been reported. The first is a sudden small frequency jump Δf in both NP 0532 (the Crab pulsar) and PSR 0833 (the Vela pulsar); the second is a slow and small amplitude "wobble" of frequency ν in the Crab pulsar frequency. A number of explanations for these jumps have been suggested, based on the model of a pulsar as a rotating neutron star—(1) the near passage of a planet in an orbit of high eccentricity; (2) a fluid instability caused by the crust of the neutron star rotating more slowly than its core; (3) a sudden relaxation of strains built up in the stellar crust or, in other words, a starquake. Suggested mechanisms for the "wobble" include (a) induced motion by yet another planet; (b) free precision of a nonspherical star; (c) normal mode vibrations of quantised vortex lines within the rotating superfluid core. The various models for the frequency jumps have different consequences for the subsequent behaviour of the "wobble" frequency. If explanations (3) and (b) apply there should be a considerable and predictable post-jump decrease in the Crab "wobble" frequency, and such a model, together with the similarity between the Crab pulsar "wobble" frequency and its residual jump after a few weeks supports the notion of a relatively weak crust in the Crab which relaxes every few years. In the analysis presented, consideration is given to a rapidly spinning, axially symmetric, slightly oblate spheroid whose paraxial moment of inertia exceeds its perpendicular moment of inertia. The frequency jump in the Crab pulsar was initially (Sept. 28, 1969) 2.6×10^{-7}Hz, and after about a week there was a relaxation to a "permanent" $\Delta f = 4.3 \times 10^{-8}$Hz. In the starquake interpretation of such events the initial jump was associated with a sudden relaxation in shape of the slightly over-oblate crust toward the oblateness appropriate to its present rotation. The interval of a week was the characteristic relaxation time for the crust to communicate its changed angular speed to the deep stellar interior. The permanent decrease in stellar moment of inertia was then -1.4×10^{-9}. From the analysis it is calculated that after the starquake the "wobble" period would be expected to increase from 72 ± 3 days to either 95 or 170 days. The long "wobble" period in the Crab implies a shape which almost entirely relaxed to hydrodynamic, even before the small quake. This is qualitatively different from the state of the Vela crust; the Vela frequency jump implies a crust shear strain $\sim 10^{-2}$, of the order of the maximum strain which crust matter could sustain. The Crab crust, on the other hand, should be highly faulted, so that it relaxes only after a strain $\sim 10^{-5}$. Such a small strain, and another small starquake, should build up from stresses associated with the slowing down of the Crab within a very few years. (UK)

21473 SEARCH FOR HIGH-ENERGY GAMMA RAYS FROM FOUR PULSARS. Chatterjee, B. K.; Murthy, G. T.; Murthy, P. V. R.; Sreekantan, B. V.; Tonwar, S. C. (Tata Inst. of Fundamental Research, Bombay). Nature (London); 225: 839-40(28 Feb 1970).

It has been suggested that high-energy cosmic rays originate in pulsars, and if this is true, it is conceivable that pulsars may also emit ultra-high-energy pulsed γ rays with the same periodicities as observed at radio frequencies. These γ rays might be the result of the decay of π^0 mesons or the bremsstrahlung of electrons in the regions surrounding the pulsars. During April 1969 an attempt was made to detect such γ rays from CP 0950, CP 1133, AP 1541, and PSR 1642. The method adopted was based on looking for nanosecond Cherenkov light signals in excess of the

background from the direction of the pulsar under investigation using two large searchlight mirrors focussed on two fast photomultipliers. The mirrors tracked each pulsar for about an hour when close to meridian transit. Whenever a coincidence occurred within the resolving time of 5 ns between the two photomultipliers the time was recorded to a precision of 5.1 ms. The ratio of genuine Cherenkov light signals (mostly due to showers induced by cosmic rays) to chance coincidences was about 1:2, and the threshold energy of detection was estimated to $\approx 10^{13}$ eV. Observations were made at 7,200 ft in Southern India. Time-averaged phase histograms were made for each pulsar, and such a histogram is shown for CP 0950. Of the four pulsars investigated only CP 0950 showed a significant peak in one of the channels, of 5.3 standard deviations above the average. Only upper limits could be deduced for the γ ray fluxes of the other three pulsars. CP 0950 appears to be a good candidate for further observations, and it may be significant that this is also probably the nearest pulsar. (UK)

21474 SCATTERING OF X RAYS FROM PULSAR NP 0532 BY INTERSTELLAR GRAINS. Naranan, S.; Shah, G. A. (Tata Inst. of Fundamental Research, Bombay). Nature (London); 225: 834-6(28 Feb 1970).

Slysh (Nature, 224: 159(1969)) suggested that although all the observed x rays from the Crab Nebula could have originated as pulsed x rays from NP 0532, only about 10% unscattered by interstellar grains are recorded as pulsed x rays in the 1 to 10 keV region; the remaining 90% are scattered and appear as a diffuse source, about 2′ wide, in which the pulses are smeared out. It is shown, however, that the optical depth for scattering by interstellar grains is small in the 1 to 10 keV region, and that the pulsed component is reduced at most by about 20%; consequently, the observed spectrum of the pulsed component in the 1- to 100-keV region should closely correspond to the spectrum of the pulsar at the source. It is assumed that interstellar grains are single smooth spheres, that single scattering holds, and that the incident and scattered radiations have the same wavelength. It is concluded that the spectrum of the pulsed x rays from NP 0532 (in the 1- to 100-keV region) is affected only very slightly by scattering by interstellar grains, and that the major part of the x ray flux (80 to 95%, depending on the energy) arises as unpulsed x rays from the pulsar source and/or the nebula, the contribution from the former probably being quite small. (UK)

21475 A LOW-LATITUDE SURVEY FROM l^{II} = 307 TO 330° AT 2700 MHz. Day, G. A.; Thomas, B. M.; Goss, W. M. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys. Astrophys. Suppl.; No. 11, 11-18(Oct 1969).

The results of a survey of the galactic plane at 2700 MHz from longitudes 307 to 330°, latitudes ± 2° are presented as a contour map and a source list giving the positions and estimated flux densities for 117 radio sources. A computer-drawn ruled surface picture of the area between l^{II} = 324 and 328° is shown to illustrate the complexity of the region. (Australia)

21476 A LOW-LATITUDE SURVEY FROM l^{II} = 334 TO 345° AT 2650 MHz. Thomas, B. M.; Day, G. A. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 11, 19-25(Oct 1969).

Contour maps of the region of the Milky Way at 2650 MHz between longitudes 334° and 345°, latitudes ± 2° are presented. A list of sources with values of peak temperature and flux density is given. (Australia)

21477 A LOW-LATITUDE SURVEY FROM l^{II} = 345 TO 5° AT 2650 MHz. Beard, M.; Thomas, B. M.; Day, G. A. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 11, 27-34(Oct 1969).

Contour maps of the region of the Milky Way between longitudes 345° and 5°, latitudes ± 2° at 2650 MHz, are presented. A list of sources with values of peak temperature and flux density, is given. (Australia)

21478 AN 11-CM MAP OF A REGION IN VELA. Manchester, B. A.; Goss, W. M. (CSIRO, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 11, 35-41(Oct 1969).

This paper presents 11 cm. contour maps of a region in Vela between right ascensions 08h 52m and 09h 06m and declinations −41 and −50°. The two intense HII regions RCW 36 and 38 are included in this survey. (Australia)

21479 EXTRAGALACTIC RADIO ASTRONOMY. Moffet, A. T. (California Inst. of Tech., Pasadena). pp 219-300 of Astrophysics and General Relativity. Vol. I. /Chretien, M. (ed.). New York: Gordon and Breach, Science Publishers, Inc. (1969).

A short historical sketch and a brief treatment of nomenclature and instrumental concepts are given. The bulk of the observational material on extragalactic radio sources is summarized. The optical counterparts of the radio sources are described, together with the intrinsic properties of the sources, which are inferred from combining the radio and optical observations. The theory of synchrotron radiation is reviewed, with applications to some of the observed features of the sources. The energetics and proposed explanations for the evolution of the sources are reviewed. (W.D.M.)

21480 NEW RADIO-WAVE TECHNIQUE IN X-RAY ASTRONOMY. Edwards, P. J. (Otago Univ., N. Z.). Proc. Astron. Soc. Aust.; 1: 290-1(Sep 1969).

Very-low-frequency radio-wave techniques are used to detect the enhancement in ionospheric D region conductivity with x radiation from Sco XR-1 and Cen XR-2. No change was apparent in the Sco XR-1 flux, and the Cen XR-2 flux appeared consistent with the shock-wave model of Edwards. (Australia)

21481 THE ENIGMA OF THE QUASI-STELLAR OBJECTS, PART I. Demaret, Jacques (Univ., Liege). Rev. Quest. Sci.; 30: 453-79(Oct 1969). (In French).

The observations of quasars during the 1960's are reviewed and properties of these objects classified. Data reviewed include general properties, identification, spectra, distribution of energy, radio emission, variations of optical and radio flux, movement of the objects, absorption and diffusion of flux emitted, and distribution. The impact of these studies on the interpretation of the constitution of intergalactic space is reviewed, and the origin of stellar objects in certain preferential regions may be associated with interpretations of the redshift found. Further reviews will incorporate empirical models of regions producing spectral rays and emitting continuous radiation, the nature of the redshift and the distance of quasars, and theories of the sources of energy of quasi-stellar objects. (BBB)

21482 DISCUSSION PAPER: X-RAY ASTRONOMY. Garmire, Gordon (California Inst. of Tech., Pasadena). Ann. N. Y. Acad. Sci.; 163: 113-17(4 Sep 1969).

The discovery and characteristics of x-ray emission from objects outside of the solar system are reviewed. The most promising processes currently used to explain such radiation are thermal bremsstrahlung from a hot plasma, blackbody radiation from a very hot star or neutron star, inverse Compton scattering of photons by high-energy electrons, and magnetic bremsstrahlung from high-energy (≥ 1 BeV) electrons in a magnetic field. No spectra corresponding to blackbody radiation have been so far observed out of the 5 sources studied. The most brilliant source, Sco X-1, appears to have a spectrum corresponding to a plasma with a temperature of about 60 million degrees. The optical identification of the x-ray-emitting object Sco X-1 is mentioned, and a survey of the sky to a limit of about 0.2 photon/cm^2/sec in the 2 to 8 Å band and to a lower level over selected regions is described. Most of the sources detected lie near the plane of the Galaxy, implying that these sources are in the Galaxy and probably not too distant. How the distances to the x-ray sources can be determined is explained. Future studies that are planned to study these sources are outlined. (BBB)

21483 SPECTRA OF DISCRETE RADIO SOURCES IN A DECAMETRIC WAVELENGTH RANGE. Braude, S. Ya.; Zhuk, I. N.; Lebedeva, O. M.; Men, A. V.; Ryabov, B. P. (Inst. of Radiophysics and Electronics, Kharkov). Ukr. Fiz. Zh.; 15: 1-33(Jan 1970). (In Russian).

The analysis was carried out of the spectra measurements of discrete sources of cosmic radio waves in a decametric-wavelength range. The spectral indices are presented for 113 discrete sources. A new classification of decametric spectra of discrete sources is introduced. According to this classification, 59 sources are related to type I (linear spectra), 8 to type II (negative curvature), 29 to type III (positive curvature), and 3 to type IV (variable curvature). Different problems related to generation and absorption of radio waves in the discrete sources are discussed and used for interpretation of various types of spectra. The analysis of preliminary data on radio-wave absorption of remote metagalactic sources in ionized metagalactic hydrogen is discussed, together with the question on possible values of temperature and density of the latter. (auth)

21484 SEARCH FOR PULSED GAMMA EMISSION FROM TWO PULSARS. Ables, J. G.; Durdin, J. M.; Gregory, A. G. (Adelaide Univ.). Proc. Astron. Soc. Aust.; 1: 286-8(Sep 1969).

An attempt was made to observe pulsed gamma radiation from southern pulsars, PSR 0833-45 and MP 0959. Negative results are reported for the former. An apparently positive result for MP

0959 cannot be considered significant without better knowledge of the pulse-repetition frequency. (Australia)

21485 LOW-LATITUDE SURVEY FROM 1^{II} = 288 TO 307° AT 2650 MHz. Thomas, B. M.; Day, G. A. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 11, 3-10(Oct 1969).

Contour maps of the region of the Milky Way between longitudes 288 and 307°, latitudes ± 2° at 2650 MHz, are presented. A list of sources with values of peak temperature and flux density is given. (Australia)

21486 A CATALOGUE OF DISCRETE CELESTIAL X-RAY SOURCES. Dolan, Joseph F. (Case Western Reserve Univ., Cleveland). Astron. J.; 75: 223-30(Apr 1970).

A comprehensive list is given of all sources of discrete celestial x radiation observed in the energy region above 2 keV whose positions were published before December 1, 1969. Identities have been pointed out between the sources observed (and given different designations) by different observers. Fluxes are given for each source in the 2 to 10- and 20 to 35-keV regions. (auth)

21487 USE OF HIGHLY REFLECTING CRYSTALS FOR SPECTROSCOPY AND POLARIMETRY IN X-RAY ASTRONOMY. Angel, J. R. P.; Weisskopf, M. C. (Columbia Univ., New York). Astron. J.; 75: 231-6(Apr 1970).

The way in which Bragg reflection can most efficiently be used for spectroscopy and polarimetry in x-ray astronomy is discussed, and it is shown that both types of measurement are best carried out with crystals of high integrated reflectivity. Graphite, lithium hydride, and tungsten disulphide crystals exhibit this property, provided they have correct domain structure. Two spectrometers making use of these crystals are described. The first, employing a grazing-incidence lens, combines both very high spectral resolution and high efficiency. The second, simply a plane-reflecting crystal and detector, demonstrates the performance that could be achieved by a small instrument in an OSO satellite. A variety of techniques for using mosaic crystals to measure polarization at the focus of a lens is discussed and performance is estimated for some possible configurations. (auth)

21488 PULSARS AND X-RAY-EMITTING SUPERNOVA REMNANTS. Holt, S. S.; Ramaty, R. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Lett.; 5: 89-91(Mar 1970).

X-ray emission from a supernova remnant may indicate the existence of a rotating neutron star within the nebula. The properties of candidate pulsars in Cassiopeia A and Tycho's supernova are investigated. (auth)

21489 EXPANSION ENERGY OF THE CRAB NEBULA. Trimble, Virginia; Rees, Martin (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett.; 5: 93-7(Mar 1970).

Calculations show that the kinetic energy input required to produce the observed acceleration of the expansion of the Crab Nebula is between 2 and 4×10^{38} ergs/sec. This value is consistent with a model for pulsars which, at present, converts virtually all of the rotation energy of a neutron star into relativistic particle energy. Rather stringent limits can, however, be placed upon the relativistic particle energy accumulated by the nebula over its lifetime and, thus, upon input rates in the past. (auth)

21490 H109α RECOMBINATION LINE MEASUREMENTS OF THE W51 REGION. Wilson, T. L. (Massachusetts Inst. of Tech., Cambridge); Mezger, P. G.; Gardner, F. F.; Milne, D. K. Astrophys. Lett.; 5: 99-103(Mar 1970).

A search for H109α emission at nine different positions within the W51 complex with the 210-ft radio telescope at Parkes, beamwidth 4 arc min at 5 GHz, indicates (i) the thermal component G 48.6 + 0.0 has a very low radial velocity (+21 km/sec) and is not a member of the W51 complex; (ii) six thermal components have radial velocities ranging from 53 to 72 km/sec and appear to be members of two associations of giant H II regions located close to the tangential point of the Sagittarius spiral arm; (iii) since no H109α emission was found at two positions on the extended component, it is assumed to be nonthermal, and is considered to be unrelated to the W51 complex. (auth)

21491 MODEL OF EXTRAGALACTIC RADIO SOURCES. Mills, D. M.; Sturrock, P. A. (Stanford Univ., Calif.). Astrophys. Lett.; 5: 105-10(Mar 1970).

A model is proposed for the compact bright radio sources ejected from radio galaxies and quasars, and it is shown that this model gives good agreement with the characteristic brightness distribution and polarization behavior of these sources. Specific application is made to the radio source Cygnus A. (auth)

21492 SEARCH FOR CIRCULAR POLARIZATION IN EXTRAGALACTIC COMPACT RADIO SOURCES AT 3240 MHz. Seaquist, E. R. (Univ. of Toronto). Astrophys. Lett.; 5: 111-15(Mar 1970).

A search was carried out for circular polarization in twenty-nine compact radio sources at 3240 MHz. Although most sources indicate no circular polarization exceeding 1%, there is some evidence for left-hand circular polarization of this order in the sources DA 344 and NRAO 140. (auth)

21493 6-CM RECOMBINATION LINE OBSERVATIONS OF THE 30 DORADUS NEBULA. Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, West Va.); Wilson, T. L.; Gardner, F. F.; Milne, D. K. Astrophys. Lett.; 5: 117-21(Mar 1970).

Radio recombination line observations of the thermal component of the 30 Doradus Nebula in the Large Magellanic Cloud indicate that the nebula possesses an electron temperature, internal turbulence, and helium abundance that are much higher than average. In addition, the radial velocity from the radio line measurements is somewhat lower than previous estimates made in the optical range. This apparent discrepancy between the radio and optical abundances is not explained; however, the radio results may refer to a dense inner region of the nebula which is not easily observed with optical techniques. (auth)

21494 PHOTOIONIZATION OF INTERGALACTIC HYDROGEN BY QUASARS. Arons, Jonathan; McCray, Richard (Harvard Coll., Cambridge, Mass.). Astrophys. Lett.; 5: 123-7(Mar 1970).

Quasars may photo-ionize intergalactic hydrogen gas of high density ($\rho_0 \approx 10^{-29}$ g cm^{-3}) sufficiently to explain the absence of intergalactic absorption features, provided that: (a) their optical continua extend beyond the Lyman limit, and (b) Schmidt's law for the increase in number density of quasars holds out to redshifts $z \approx 3$. The selection effect of Rees prevents finding quasars beyond $z \approx 2.5$ by standard methods. The temperature of the gas may be well below 10^{6}K. (auth)

21495 FLUX DENSITIES OF SOME RADIO SOURCES IN THE FREQUENCY RANGE 12 TO 25 MHz. Braude, S. Ya.; Lebedeva, O. M.; Megn, A. V.; Ryabov, B. P.; Zhouck, I. N. (Inst. of Radiophysics and Electronics, Kharkov). Astrophys. Lett.; 5: 129-32 (Mar 1970).

Measurements are presented of the flux densities of 33 discrete radio sources, made with the radio telescope UTR-1 in Grakovo, at frequencies ranging from 12.6 to 25 MHz. (auth)

Solar Phenomena

Refer also to abstracts 21519, 21620–21622, 21695, and 21696.

21496 (LA–4343) MODEL FOR FORMATION OF SOLAR SYSTEMS FROM MASSIVE SUPERNOVA FRAGMENTS. Brown, Wilbur K. (Los Alamos Scientific Lab., N. Mex.). 21 Oct 1969. Contract W-7405-eng-36. 28p. Dep. CFSTI.

A model for formation of solar systems is presented, which rests primarily on the hypothesis that under the proper conditions the shell ejected from a supernova will fragment into separate volumes. It is hypothesized that each massive fragment will expand and then eventually contract to form a separate solar system. Mathematically, in essence, an initial angular momentum distribution is established for the fragment volume, which is then mapped into a mass distribution within a circular disk conserving the angular momentum of each particle during the process. It is found that a right circular cylindrical fragment volume, the faces of which represent the inner and outer surfaces of the shell, yields mass distributions in the disk quite descriptive of our solar system over a wide range of combinations of the parameters involved. The approximate angular momentum of the Sun results if the innermost portion of the planetary disk is included in the new Sun. If it is further hypothesized that the shell surface breaks up into polygonal areas, the vertices of a resulting polygonal cylinder yield a series of maxima in the form of rings in the planetary disk mass distribution. The characteristic spacing of these rings is quite similar to that of our planets. The gap between Mars and Jupiter, and the orbital tilt of Pluto are intrinsic to the model. A preliminary fit to our system is presented, along with future plans for computer programs. Hypotheses are set forth that could account for the low masses and high densities of the minor planets, and for a massive low-angular-momentum Sun. Also presented are speculations based on the model, primarily concerning the peculiarities of our solar system, but including the possible extension of the model to galactic formation. (auth)

21497 ENERGY OF CURRENT-EDDY BLOBS. Ermakov, F. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 481-5(1969).

Translated from Geomagn. Aeron.; 9: 593-8(1969).

It is assumed that finite current-eddy regions of favorable energy and without field discontinuities may form in a potential magnetokinematic plasma flux. Considering this configuration to be stationary and neglecting its dissipation, one can obtain from the virial theorem a relationship between the average field values inside the blob with its geometry and external conditions. The detailed structure of the internal fields cannot be determined without additional assumptions. It is demonstrated that some of the known special models (Hill, Beltrami, Lundqvist) lead to unstable blobs. (auth)

21498 HIGH-RESOLUTION SEARCH FOR SOLAR GAMMA-RAY LINES. Womack, E. Allen; Overbeck, James W. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res.; 75: 1811-16(1 Apr 1970).

A balloon-borne directional spectrometer for gamma rays from 30 keV to 6.3 MeV is described, based on a high-resolution Ge(Li) detector. The Sun was observed from 4.7 g cm^{-2} on May 5, 1968. Seven lines present in the background are attributed to neutron capture reactions in the detector. No evidence of monochromatic solar gamma-ray emission was detected. An upper limit of 6.9×10^{-3} cm^{-2} sec^{-1} was found for 511 keV radiation from the quiet Sun. Upper limits 4.5×10^{-3} cm^{-2} sec^{-1} and 3.2×10^{-2} cm^{-2} sec^{-1} were found for the flux of 2.223-MeV gamma rays at the Earth for the quiet Sun and for a period of subflare activity, respectively. (auth)

21499 SOLAR WIND STRUCTURE DETERMINED BY CO-ROTATING CORONAL INHOMOGENEITIES. 1. VELOCITY-DRIVEN PERTURBATIONS. Siscoe, G. L.; Finley, L. T. (Univ. of California, Los Angeles). J. Geophys. Res.; 75: 1817-25(1 Apr 1970).

Previous work on nonspherically symmetric solar-wind models is extended, which involved only two independent variables, by deriving the perturbation equations for the three independent variables, r, θ, and η, of a spherical polar coordinate system corotating with the Sun. The results can be applied to an arbitrary distribution of coronal inhomogeneities with lifetimes long as compared with a flow time of several days and, hence, are restricted to large scale solar-wind variations. Two special distributions are given as examples, one north–south symmetric and one north–south antisymmetric; both have four perturbation cycles in one solar rotation. Boundary conditions appropriate to a "pure fast–slow stream interaction" are applied. Comparison with solar wind data suggests that this simple boundary condition explain occasionally seen structures, but more generally a boundary condition that includes entropy variations is implied. (auth)

21500 DISCUSSION PAPER: WHAT TECHNOLOGIES WILL BE NEEDED TO EXPLORE THE INNER PLANETS, THE OUTER PLANETS AND THEIR MOONS, COMETS AND ASTEROIDS, AND INTERSTELLAR SPACE TO DEPTHS OF 20 LIGHT-YEARS? Shipps, Paul. Ann. N. Y. Acad. Sci.; 163: 581-2(4 Sep 1969).

The technology advancement required to permit exploration of the solar system, in the realm of propulsion, is discussed. It is generally agreed, that some form of nuclear propulsion is required for most of the explorations, with rather advanced nuclear systems needed for the intermediate to higher velocity trips. A propulsion system list for advanced solar missions is presented in terms of sp. impulse: solid- and liquid-core reactors, 750 to 1200 sec; gaseous-core reactors, 1700 to 2500 sec; nuclear pulse, 2500 to > 10,000 sec; nuclear electric, 5000 to > 30,000 sec, and controlled thermonuclear reactor, 10,000 to > 100,000 sec. The first three systems listed are high-thrust engines (capable of accelerating an appropriate space vehicle at a 1-g rate), whereas the latter two (and the liquid-core reactor) are only capable of thrusts some $^1/_{1000}$ of that amount. The high-thrust systems are obviously more maneuverable and more versatile, particularly when it is desired to decelerate and dwell in orbit about a planet, or to descend and land. It is suggested that the most important single factor in the selection of a space vehicle propulsion system is a large margin in performance capability, that is, a large design safety factor in payload and/or mission velocity. The reasons are primarily economic. For the proposed extensive exploration of the solar system, it would be wasteful of the world's technical manpower and resources to highly optimize, each in turn, a series of incrementally improved vehicle and propulsion systems. When the complete system is considered, the cost, of optimizing a vehicle system and all of its subsystems in order to make a marginally capable propulsion concept barely suffice, can be either prohibitive or constraining. Conversely, using a propulsion system having performance-to-spare greatly simplifies the requirements on the vehicle and its subsystems, thus greatly reducing the cost, and often the time, for development of the complete package. (BBB)

21501 INVESTIGATIONS OF COSMIC-RAY INTENSITY VARIATIONS IN ANTARCTICA. Pomerantz, Martin A.; Duggal, Shakti P. (Franklin Inst., Philadelphia). Antarctic J. U. S.; 4: 226-7 (Sep-Oct 1969).

In 1968 two instances were recorded of the emission by the Sun of nuclear particles having energies as high as several hundred MeV, a rare occurrence which, on the average, happens only once every two yr. The November 18, 1968 event is the first in which direct impact of solar particles in the polar regions has been observed with the new, high counting-rate neutron monitors. A chart shows the intensity of solar cosmic rays as recorded by the Bartol neutron monitors at McMurdo and South Pole Stations, as well as at the Arctic station at Thule, Greenland, and at Swarthmore, where the particles arrive from the equatorial plane. Because of its altitude, the South Pole detector responds to lower-energy particles than the other stations, hence the magnitude of the increase is enhanced. The most striking feature is the sharp rise time, in marked contrast to the slower-developing previous events, particularly the last one (January 28, 1967). Maximum intensity was attained 15 min after onset, and the major activity subsided in about 2 hr. This event occurred while a cosmic-ray storm was in progress, and was associated with a relatively minor limb flare at N21° W87° on the solar disk. The spectrum, deduced from an analysis of data from 18 stations, was of the form k exp(– P/550), where P is the magnetic rigidity in units of MV. (BBB)

21502 THE CORRELATION OF X RADIATION (2 TO 12 A) WITH MICROWAVE RADIATION (10.7 cm) FROM THE NONFLARING SUN. Gibson, M. Jean. Iowa City, Iowa; Univ. of Iowa (1969). 129p.

Thesis.

Absolute values of daily averages of the soft x-ray flux F(2 to 12 Å) from the nonflaring sun are reported for 734 days during the period July 1, 1966 to December 25, 1968. The measurements were made with three thin-windowed Geiger–Mueller tubes on Explorer 33 and one on Explorer 35. The daily values were bounded between ≈ 0.4 and ≈ 6.8 milliergs/cm^2 sec during this entire period. The daily values of solar radio power flux density P(2800 MHz) as reported by the Algonquin Radio Observatory, Ottawa are correlated with these daily x-ray values. As suggested by theory, the correlation is made between ln F and 1/P. The correlation coefficient r is found to be 0.857 with 99% probability that the population correlation coefficient is in the range $0.831 \leq P \leq 0.881$. Assuming that there is scatter in both the x-ray flux and in the radio flux the least squares fit is $F = 27.3 \exp(-385.2/P)$, where F is in milliergs/cm^2 sec and P is in flux units of 10^{-22} watts/m^2 Hz. From a study of the theoretical relationships the following interpretation is made: the average temperature of the emitting regions is in the range $2.3 \leq T \leq 6.8$ million degrees and the average emission measure is in the range $7.6 \leq \int N_e^2 \, dV \leq 33.5 \times 10^{48}/cm^3$. The area of the radio emitting region is much greater than the area of the x-ray emitting region. (Diss. Abstr. Int., B)

21503 REVERSALS OF CIRCULAR POLARIZATION DURING MICROWAVE SOLAR BURSTS. Marques dos Santos, P.; Kaufmann, P.; Matsuura, O. T.; Chu, B. (Mackenzie Univ., Sao Paulo, Brazil). Astrophys. Lett.; 5: 85-8(Mar 1970).

Rare cases of solar noise bursts observed at 7 GHz show circular polarization that reverses with time. The effect is caused by bursts that are generated simultaneously at two different plages in the Sun, each with a different sense of polarization. Multi-burst sources can also show the effect. Observations of sources located in different hemispheres suggest the possibility of a physical connection between the coincidence flares. (auth)

Galaxies

21504 PK 0048-09: A POSSIBLE RADIO VARIABLE GALAXY. Stull, M. A. (Univ. of Michigan, Ann Arbor). Nature (London); 225: 832-3(28 Feb 1970).

Widely differing values of flux densities were measured at 8,000 MHz on different dates for this galaxy, which is believed to be varying. The observations were made between Nov. 1968 and Nov. s969 with the Michigan 85 ft radiotelescope, using a wide-band tunnel diode radiometer and a dual feed-horn system. The measured flux densities are shown graphically as a function of time; a decline of 17% was observed between Nov. 1968 and Feb. 1969, followed by an increase of 83% between Feb. and July, the flux then remaining nearly constant until Oct. and then appearing to decline by about 20% over a period of 10 days. Since then no significant change has been observed. Comparisons are made with PK 1345 + 12, 3C 264, PK 0124 + 18, 3C 227, 3C 444, 3C 136.1, 3C 71, and PK 1313, all of which showed no significant changes. The radio spectrum of PK 0048-09 is also shown, a remarkable feature of which is the apparent lack of a low-frequency component. According to current ideas on the evolution of radio sources this indicates that the radio source in PK 0048-09 is of recent origin and considerably younger than those in most radio galaxies. Compar-

isons are also made with the varying radio galaxies 3C 84 (NGC 1275) and 3C 120, which are classified as Seyfert galaxies; the variations in 3C 120 are not unlike those reported for PK 0048-09. It is thought that the changes recorded in the latter are probably intrinsic to the source. (UK)

21505 STATISTICAL MECHANICS OF STELLAR SYSTEMS. Lynden-Bell, D. (Royal Greenwich Observatory, Eng.). pp 1-57 of Astrophysics and General Relativity. Vol. I. /Chretien, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

Topics covered in this lecture include unknowns in the evolution of galaxies, galaxy formation and origin of the elements, problem of statistical mechanics, statistical mechanics of star pairs, statistical mechanics of uncorrelated stars in a spherical box, the gravothermal catastrophe, relaxation times (numerical fluctuations in the steady-state potential), and statistical mechanics without individual encounters. (W.D.M.)

21506 PHYSICS OF THE INTERSTELLAR AND INTERGALACTIC MEDIUM. Field, G. B. (Univ. of California, Berkeley). pp 61-111 of Astrophysics and General Relativity. Vol. I. /Chretien, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

Attention is focussed on two main problems — the thermal and dynamical state of H I and H II regions, and some of the main observational data and the key theoretical ideas that are now being applied to sort them out. The intergalactic medium is discussed in terms of H I and H II regions. (W.D.M.)

21507 ATOMIC AND MOLECULAR HYDROGEN IN INTERSTELLAR SPACE. Carruthers, George R. (Naval Research Lab., Washington, D. C.). Space Sci. Rev.; 10: 459-82(Feb 1970).

The present state of knowledge of the abundances and physical state of interstellar atomic and molecular hydrogen is reviewed. Much new data in this area have been obtained in recent rocket observations. There have also been new developments as a result of ground-based infrared and 21-cm observations, and theoretical research. Rocket observations of the Lyman-α interstellar absorption line of atomic hydrogen indicate that, in many directions in the sky, atomic hydrogen is up to a factor of 10 less abundant than previously indicated by 21-cm emission measurements. In the direction of the Orion Nebula, most of the absorbing gas appears to be concentrated in the near vicinity of the nebula and to have a temperature considerably lower than the average of 100 K obtained from 21-cm emission measurements. Molecular hydrogen appears essentially absent from the general interstellar medium, as confirmed by theoretical studies of photodissociation processes. However, ground-based infrared and 21-cm studies indicate that the hydrogen in dark dust clouds is mostly molecular. (auth)

21508 DYNAMICS OF SELF-GRAVITATING SYSTEMS; STRUCTURE OF GALAXIES. Lin, C. C. (Massachusetts Inst. of Tech., Cambridge). SIAM (Soc. Ind. Appl. Math.) Rev.; 11: 127-51(Apr 1969).

A brief survey of the statistical theory of a stochastic process in which the stars are the atoms is presented. The problem is examined both collectively and individually. The deductions of the mathematical theory can yield results for the Galaxy satisfactory from the observational point of view. Stellar systems for which the relaxation process is not important are studied, in particular with respect to the following two problems: (a) what is the nature of the spiral pattern observed in disk-shaped galaxies? (b) why are some of the galaxies in the shape of a rotating bar? The first problem is dealt with by the concept of collective modes, important in plasma physics. In the study of the second problem, insight may be gained from classical studies of rotating fluid masses. It would be unwise to divide the applied mathematics artificially in terms of discrete and continuous parts. These mathematical studies enable better understanding of the nature of collective modes and to raise again, in sharper focus, some fundamental questions on the relaxation process in a "collision-less" system. The point toward the importance of the study of nonlinear random processes, might contribute to the stimulation and the development of a general mathematical theory. (BBB)

21509 OBSERVATIONS OF DISCRETE SOURCES AND THE GALACTIC SPUR IN THE 20- TO 40-MHz RANGE. Guidice, Donald Anthony. Columbus, Ohio; Ohio State Univ. (1969). 262p. Thesis.

An investigation of the spectra of certain discrete radio sources and the brightness temperature distribution of the Galactic Spur in the northern hemisphere was carried out for the 20 to 40 MHz frequency range. Observations were made on the Arecibo Ionospheric Observatory's 1000-foot radio telescope during October–November 1964, April 1965, March 1966, and March–April 1967. (TSS) (Diss. Abstr. Int., B)

21510 GROUPS AND CLUSTERS OF GALAXIES. Snow, T. P. Jr. (Yale Univ. Observatory, New Haven). Astron. J.; 75: 237-8(Apr 1970).

Descriptions and locations of 34 previously unreported possible groups and clusters of southern galaxies are given. These results are based upon direct inspection of photographic plates taken with the 20-inch double astrograph of the Yale–Columbia Southern Observatory at El Leoncito, Argentina. (auth)

Cosmology

Refer also to abstract 21506.

21511 GRAVITATIONAL COLLAPSE. Misner, C. W. (Univ. of Maryland, College Park). pp 115-215 of Astrophysics and General Relativity. Vol. I. /Chretien, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

A brief review is given of differential geometry and general relativity. Topics considered include collapse studied from the exterior Schwarzschild metric, relativistic hydrodynamics and some static solutions, relativistic spherical hydrodynamics, and collapse and cosmology. (W.D.M.)

Planetary Phenomena

Refer also to abstracts 20706–20711, 20721–20724, 20730–20736, 20738, and 20739.

21512 THE ATMOSPHERE OF JUPITER. Owen, Tobias (Illinois Inst. of Tech., Chicago). Science; 167: 1675-81(27 Mar 1970).

Investigations of the composition of the atmosphere of Jupiter during the last decade have strongly indicated that this planet represents the composition of the original cloud of gas and dust from which the solar system formed. Topics discussed include spectroscopic observations, hydrogen, helium, methane, ammonia, possible minor constituents, comparison with solar abundances, origin and evolution of solar system, nature of the colors, and biological significance. (W.D.M.)

21513 GEODESIC EQUATION AND PLANETARY MOTION FROM A QUATERNION REPRESENTATION OF GENERAL RELATIVITY. Sachs, M. (Cambridge Univ., Eng.). Nuovo Cim.; 66B: 137-56(11 Mar 1970).

The quaternion representation of general relativity derived in a previous study is applied to the problem of planetary motion. It is found that while the outward appearance of the geodesic equation is the same in this formalism as it is in the conventional Einstein formulation, when the derivatives are expressed with respect to the differential increment in four-space, ds, the special frame of reference in which this equation is recast in terms of derivatives with respect to the time changes (i.e. equations of motion) are somewhat different in the two formulations. The reason has to do with the fact that in this theory scalar invariant ds obeys the algebra of a quaternion-number field while in the Einstein formulation it belongs to a real-number field and the bound states of planets are described by quaternion-field variables that depend on the time parameter in a phase factor while there is no time dependence at all in the metric-tensor formulation for this physical situation. As a result of this alteration in the description of a planetary orbit, it is found that the angular momentum, L_q, as compared with the angular momentum in the Einstein and Newtonian theories is as follows: $L_q : L_E : L_N = mK \exp[-2\gamma/r] : mK(1-2\gamma/r)^{\frac{1}{2}} : mK$, where K is a constant that characterizes a particular orbit, m is the planetary mass and γ is the Schwarzschild radius. On the other hand, it is found that to the order of perturbation that is required to compare with the observations of the anomalous part of the perihelion precession of Mercury's orbit, the theoretical prediction that comes from this analysis is in numerical agreement with its prediction from Einstein's theory and with the data. Based on this analysis, it is suggested that future experimentation involving controlled artifical-satellite orbits could possibly be used to differentiate between the predictions of this theory and those of Einstein's tensor formulation and the classical theory. (auth)

21514 ALPHA RADIOACTIVITY OF THE LUNAR SURFACE AT THE LANDING SITES OF SURVEYORS 5, 6, AND 7. Turkevich, Anthony L. (Univ. of Chicago); Patterson, James H.; Franzgrote, Ernest J.; Sowinski, Kenneth P.; Economou, Thanasis E. Science; 167: 1722-4(27 Mar 1970).

Evidence has been obtained for a radioactive deposit on the lunar surface at Mare Tranquillitatis with a total intensity of 0.09 ±

0.03 alpha disintegration per second per square centimeter. The presence of polonium-210 in amounts that are close to equilibrium indicates a continuous turnover rate of lunar material at this site of less than 0.1 micrometer per year. The lack of such a deposit at two other lunar sites suggests lower local concentrations of uranium there. (auth)

21515 DISCUSSION PAPER: RECOVERY OF DEUTERIUM IN THE ATMOSPHERE OF JUPITER. Hinckley, R. B.; Reid, R. C.; Glaser, P. E. (Arthur D. Little, Inc., Cambridge, Mass.). Ann. N. Y. Acad. Sci.; 163: 554-8(4 Sep 1969).

A serious logistic problem in long space flights is the necessity to carry a round-trip fuel supply or to obtain fuel either at the terminus or at an intermediate stop. Spacecraft in the future will probably be nuclear-powered and, hopefully, of a fusion-reaction type. If the fusion type were realized, it would be imperative to provide and store deuterium. Several possibilities for obtaining deuterium in the atmosphere of one of the gas-giant planets, such as Jupiter, are explored. Most "Earth" methods for preparing deuterium in a reasonably pure state are rejected as being unsuitable for application in space. To obtain deuterium from hydrogen present in the atmosphere of Jupiter, some method must be found to collect, liquefy, and separate the hydrogen and deuterium. Deuterium is probably present at a higher concentration than on Earth, and values as high as 700 to 800 ppm have been suggested. One proposal is to orbit a vehicle in the stratosphere and collect the hydrogen (deuterium)–helium mixture by a ram action. The hydrogen would be liquefied and rectified to produce deuterium. Also considered is location of the deuterium separation plant on one of Jupiter's moons, or on Saturn. The Galilean satellites of Jupiter would appear to be logical locations for large separation plants provided their atmospheres are found to be suitable. The concept of refueling a fusion device on Jupiter or some other gas giant does not appear to be impossible (unless subsequent studies show no hydrogen to be present). (BBB)

21516 NONEQUILIBRIUM RADIATION FROM PLANETARY ATMOSPHERES. Thompson, Samuel Lee. Lexington, Ky.; Univ. of Kentucky (1966). 105p.

Thesis.

A possible solution to the problem of "measured" atmospheric temperatures of Jupiter too high to be in equilibrium with the incident solar radiation is studied. It is demonstrated that another interpretation of the measurements of the 8 to 14-μ emission is possible. The high radiation "temperature" is thus explicable by a cascade process of the molecules in Jupiter's atmosphere wherein a high energy photon is received from the Sun and reradiated as smaller quanta. It is also found that a possible explanation of the enhanced emission from the shadows of Jupiter's satellites is possible using the same idea. Nonequilibrium radiation and collisional deactivation processes in gases are studied. (TSS) (Diss. Abstr.)

21517 PROCEEDINGS OF THE LUNAR SCIENCE CONFERENCE HELD AT HOUSTON, TEXAS, FROM 5 TO 8 JANUARY. Science; 167: 447-793(30 Jan 1970). (CONF-700106).

Results of the first systematic studies of the Apollo 11 samples by more than 500 scientists from nine countries are compiled. In all, 144 papers were submitted; separate abstracts were prepared for 50. (W.D.M.)

For abstracts of individual papers see: 20706–20711, 20721–20724, 20730–20739, and 21518–21547.

21518 AGE OF THE MOON: AN ISOTOPIC STUDY OF URANIUM–THORIUM–LEAD SYSTEMATICS OF LUNAR SAMPLES. Tatsumoto, Mitsunobu; Rosholt, John N. (Geological Survey, Denver). Science; 167: 461-3(30 Jan 1979).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Concentrations of U, Th, and Pb in Apollo 11 samples studied are low (U, 0.16 to 0.87; Th, 0.53 to 3.4; Pb, 0.29 to 1.7, in ppM) but the extremely radiogenic lead in samples allows radiometric dating. The fine dust and the breccia have a concordant age of 4.66 billion years on the basis of $^{207}Pb/^{206}Pb$, $^{206}Pb/^{238}U$, $^{207}Pb/^{235}U$, and $^{208}Pb/^{232}Th$ ratios. This age is comparable with the age of meteorites and with the age generally accepted for the Earth. Six crystalline and vesicular samples are distinctly younger than the dust and breccia. The $^{238}U/^{235}U$ ratio is the same as that in Earth rocks, and ^{234}U is in radioactive equilibrium with parent ^{238}U. (auth)

21519 AGES, IRRADIATION HISTORY, AND CHEMICAL COMPOSITION OF LUNAR ROCKS FROM THE SEA OF TRANQUILLITY. Albee, A. L.; Burnett, D. S.; Chodos, A. A.; Eugster, O. J.; Huneke, J. C.; Papanastassiou, D. A.; Podosek, F. A.; Russ II, G. Price; Sanz, H. G.; Tera, F.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Science; 167: 463-6(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The $^{87}Rb-^{87}Sr$ internal isochrons for five rocks yield an age of $3.65 \pm 0.05 \times 10^9$ years which presumably dates the formation of the Sea of Tranquillity. Potassium–argon ages are consistent with this result. The soil has a model age of 4.5×10^9 years, which is best regarded as the time of initial differentiation of the lunar crust. A peculiar rock fragment from the soil gave a model age of 4.44×10^9 years. Relative abundances of alkalis do not suggest differential volatilization. The irradiation history of lunar rocks is inferred from isotopic measurements of gadolinium, vanadium, and cosmogenic rare gases. Spallation xenon spectra exhibit a high and variable $^{131}Xe/^{126}Xe$ ratio. No evidence for ^{129}I was found. The isotopic composition of solar-wind xenon is distinct from that of the atmosphere and of the average for carbonaceous chondrites, but the krypton composition appears similar to average carbonaceous chondrite krypton. (auth)

21520 $^{40}Ar/^{39}Ar$ DATING OF LUNAR ROCK SAMPLES. Turner, Grenville (Univ. of Sheffield, Eng.). Science; 167: 466-8(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Seven crystalline rock samples returned by Apollo 11 were analyzed in detail by means of the $^{40}Ar-^{39}Ar$ dating technique. The extent of radiogenic argon loss in these samples ranges from 7 to ≥48%. Potassium–argon ages, corrected for the effects of this loss, cluster relatively closely around the value of 3.7×10^9 years. Most of the vulcanism associated with the formation of the Mare Tranquillitatis presumably occurred around 3.7×10^9 years ago. A major cause of the escape of gas from lunar rock is probably the impact event which ejected the rock from its place of origin to its place of discovery. Upper limits for the times at which these impact events occurred have been estimated. (auth)

21521 URANIUM–THORIUM–LEAD ISOTOPE RELATIONS IN LUNAR MATERIALS. Silver, Leon T. (California Inst. of Tech., Pasadena). Science; 167: 468-71(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The lead isotopic compositions and uranium, thorium, and lead concentrations were measured on six samples of material from the Sea of Tranquillity. The leads are moderately to very radiogenic; the initial lead concentrations are very low; the uranium and thorium levels are 0.26 to 0.88 and 0.87 to 3.35 parts per million, respectively. The Th/U ratios cluster about a 3.6 value. Apparent ages calculated for four rocks are $4.1 \text{ to } 4.2 \times 10^9$ years. Dust and breccia yield apparent ages of $4.60 \text{ to } 4.63 \times 10^9$ years. The uranium–lead ages are concordant, or nearly so, in all cases. The lunar surface is an ancient region with an extended record of events in the early history of the solar system. The discrepancy between the rock ages and dust ages poses a fundamental question about rock genesis on the Moon. (auth)

21522 RUBIDIUM–STRONTIUM, URANIUM, AND THORIUM–LEAD DATING OF LUNAR MATERIAL. Gopalan, K.; Kaushal, S.; Lee-Hu, C.; Wetherill, G. W. (Univ. of California, Los Angeles). Science; 167: 471-3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Rubidium and strontium concentrations and strontium isotopic compositions were measured on whole rock samples and density fractions of microgabbro. Density fractions on two rocks define isochrons of 3400 and 4500 million years with large uncertainties owing to low enrichment of radiogenic strontium. Lead from fine surface material is highly radiogenic. An age of 4750 million years was calculated from the ratio of $^{207}Pb/^{206}Pb$. The concentrations of uranium, thorium, and lead isotopes are consistent with the evolution of lead in a 4700-million-year-old closed system characterized by the ratios of uranium to lead and of thorium to lead in this surface material. (auth)

21523 RUBIDIUM–STRONTIUM RELATIONS IN TRANQUILLITY BASE SAMPLES. Hurley, P. M.; Pinson, W. H. Jr. (Massachusetts Inst. of Tech., Cambridge). Science; 167: 473-4(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Preliminary total rock analyses disclosed a greatly different Rb depletion between two groups of these igneous rocks, and ratios of $^{87}Sr/^{86}Sr$ indicate that the Rb depletion in these materials must have occurred during or shortly after the accretion of the terrestrial planets. (auth)

21524 RUBIDIUM–STRONTIUM AGE AND ELEMENTAL AND ISOTOPIC ABUNDANCES OF SOME TRACE ELEMENTS IN LUNAR SAMPLES. Murthy, V. Rama (Univ. of Minnesota, Minneapolis); Schmitt, R. A.; Rey, P. Science; 167: 476-9(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Data on six lunar crystalline rocks give an apparent Rb–Sr isochron age of $4.42 \pm 0.24 \times 10^9$ years (95% confidence limits) and initial $^{87}Sr/^{86}Sr$ ratio similar to that in a basaltic achondrite. Relationships between K, Rb, Sr, and Ba and depletion of Eu in these samples point to plagioclase separation from the melts that produced these rocks. The abundance of ^{157}Gd in the three lunar samples is similar to terrestrial abundance within <0.2%, thus setting a limit of $< 6 \times 10^{15}$ neutrons/cm^2 for the integrated thermal neutron flux difference between lunar and terrestrial materials. (auth)

21525 AGE DETERMINATIONS AND ISOTOPIC ABUNDANCE MEASUREMENTS ON LUNAR SAMPLES. Wanless, R. K.; Loveridge, W. D.; Stevens, R. D. (Geological Survey of Canada, Ottawa). Science; 167: 479–80(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

A K–Ar age of 2300×10^6 years was determined for a sample of type A crystalline rock (57,34). The presence of anomalously large quantity of ^{40}Ar, in a sample of type C breccia (65,35) precluded the calculation of its K–Ar age. Both of the rock types are characterized by low Rb/Sr ratios and consequently low $^{87}Sr/^{86}Sr$ values. The U–Th–Pb results for a sample of type D fines (84,33) yield a $^{207}Pb/^{206}Pb$ age of 4760×10^6 years, but ages based on U–Pb and Th–Pb ratios are anomalously high. Isotopic compositions of Li, K, Rb, Sr, U, and Th are very close to the accepted values for terrestrial materials. (auth)

21526 LEAD AND THALLIUM ISOTOPES IN MARE TRANQUILLITATIS SURFACE MATERIAL. Kohman, Truman P.; Black, Lance P.; Ihochi, Haruhiko; Huey, James M. (Carnegie-Mellon Univ., Pittsburgh). Science; 167: 481–3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Lead from Apollo 11 fines is more radiogenic than any meteoritic lead reported and older than any terrestrial radiogenic lead: $^{204}Pb/^{206}Pb/^{207}Pb/^{208}Pb = 1/99_{0.6}/69_{0.9}/117_{0.1}$. Comparison with primordial lead from meteoritic troilite yields a $^{207}Pb/^{206}Pb$ age of $4.7 \pm 0.1 \times 10^9$ years. The $^{238}U/^{204}Pb$ ratio is $\gtrsim 90$ and the $^{232}Th/^{238}U$ ratio is 3.9 ± 0.1. The lead content is $\gtrsim 1.7 \times 10^{-6}$. Evidently Pb was strongly depleted and Th and U strongly enriched in the formation of this material. Thallium was too low ($\lesssim 5 \times 10^{-9}$) to yield mass spectra, but indications are favorable for eventual observation of extinct natural radioactivity of ^{205}Pb. (auth)

21527 RARE EARTH ELEMENTS IN RETURNED LUNAR SAMPLES. Haskin, Larry A.; Helmke, Philip A.; Allen, Ralph O. (Univ. of Wisconsin, Madison). Science; 167: 487–90 (30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

A linear correlation between concentrations of Sm and ratios of Sm to Eu for nine lunar samples suggests that those samples could correspond to liquids from equilibrium partial melting of a common source. On the basis of partition coefficients in terrestrial systems, the fraction of melting would not have exceeded about 15% and the immediate source could have been composed of olivine, orthopyroxene, and opaque minerals plus at least 25% feldspar, with at most a few percent calcic clinopyroxene and less than 1% apatite. The large Eu depletions could also have been produced by fractional crystallization if the ratio of Eu^{2+} to Eu^{3+} in lunar magmas significantly exceeds the values for terrestrial magmas. (auth)

21528 TRACE ELEMENTS AND RADIOACTIVITY IN LUNAR ROCKS: IMPLICATIONS FOR METEORITE INFALL, SOLAR-WIND FLUX, AND FORMATION CONDITIONS OF MOON. Keays, Reid R.; Ganapathy, R.; Laul, J. C.; Anders, Edward; Herzog, G. F.; Jeffery, P. M. (Univ. of Chicago). Contracts AT(11-1)-382; NAS 9-7887. Science; 167: 490–3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Lunar soil and type C breccias are enriched 3- to 100-fold in Ir, Au, Zn, Cd, Ag, Br, Bi, and Tl, relative to type A, B rocks. Smaller enrichments were found for Co, Cu, Ga, Pd, Rb, and Cs. The solar wind at present intensity can account for only 3% of this enrichment; an upper limit to the average proton flux during the last 4.5×10^9 years thus is 8×10^9 cm^{-2} yr^{-1}. The remaining enrichment seems to be due to a 1.5 to 2% admixture of carbonaceous-chondrite-like material, corresponding to an average influx rate of meteoritic and cometary matter of 2.9×10^{-9} g cm^{-2} yr^{-1} at Tranquility Base. This is about one-quarter the terrestrial rate. Type A, B rocks are depleted 10- to 100-fold in Ag, Au, Zn, Cd, In, Tl, and Bi, relative to terrestrial basalts. This suggests loss by high-temperature volatilization before or after accretion of the Moon. Positron activities due mainly to ^{22}Na and ^{26}Al range from 90 to 220 β^+ min^{-1} kg^{-1} in five small rocks or fragments (9 to 29 g). The higher activities presumably indicate surface locations. Thorium and U contents generally agree with those found by the preliminary examination team. (auth)

21529 LUNAR ROCK COMPOSITIONS AND SOME INTERPRETATIONS. Engel, A. E. J. (Univ. of California, San Diego); Engel, Celeste G. Science; 167: 527–8(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Samples of igneous "gabbro," "basalt," and lunar regolith have compositions fundamentally different from all meteorites and terrestrial basalts. The lunar rocks are anhydrous and without ferric iron. Amounts of titanium as high as 7 wt % suggest either extreme fractionation of lunar rocks or an unexpected solar abundance of titanium. The differences in compositions of the known, more "primitive" rocks in the planetary system indicate the complexities inherent in defining the solar abundances of elements and the initial compositions of the Earth and Moon. (auth)

21530 $^{18}O/^{16}O$, $^{30}Si/^{28}Si$, D/H, AND $^{13}C/^{12}C$ STUDIES OF LUNAR ROCKS AND MINERALS. Epstein, Samuel; Taylor, Hugh P. Jr. (California Inst. of Tech., Pasadena). Science; 167: 533–5(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The $\delta\ ^{18}O$ of minerals from lunar gabbros and basalts were: plagioclases +6.06 to +6.33), pyroxenes (+5.70 to +5.95), and ilmenites (+3.85 to +4.12). The uniformity of these results indicated isotopic equilibrium in the mineral assemblages. Estimated plagioclase–ilmenite temperatures ranged from 1150 to 1340°C. The bulk $^{18}O/^{16}O$ and $^{30}Si/^{28}Si$ ratios of these lunar rocks were identical with ratios of terrestrial basalts, but the lunar glass, breccia, and dust were slightly enriched in the heavier isotopes. The lunar hydrogen (formed from solar wind) had a δ D/H of less than −873 per mil and the value may be even lower, as it was probably contaminated with terrestrial hydrogen. The $\delta\ ^{13}C$ of lunar dust and breccia was unusually high relative to reduced carbon in meteorites or on Earth. (auth)

21531 RARE GASES, HYDROGEN, AND NITROGEN: CONCENTRATIONS AND ISOTOPIC COMPOSITION IN LUNAR MATERIAL. Hintenberger, H.; Weber, H. W.; Voshage, H.; Waenke, H.; Begemann, F.; Vilscek, E.; Wlotzka, F. (Otto Hahn Inst., Mainz). Science; 167: 543–5(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The concentrations and isotopic abundances of the rare gases were investigated in fines and three types of rocks. The results obtained from different grain-size fractions and from samples etched to different degrees with nitric and hydrofluoric acids demonstrated the strong concentrations of the solar-wind component in the surface layers of the grains. Exposure ages as well as gas retention ages were determined in different types of Apollo 11 material. Hydrogen, nitrogen, and other gases were analyzed by a high-resolution mass spectrometer. As compared with that in terrestrial water, deuterium is depleted by at least a factor of 3 in the investigated type C rocks. (auth)

21532 ISOTOPIC ANALYSIS OF RARE GASES FROM STEPWISE HEATING OF LUNAR FINES AND ROCKS. Reynolds, J. H.; Hohenberg, C. M.; Lewis, R. S.; Davis, P. K.; Kaiser, W. A. (Univ. of California, Berkeley). Science; 167: 545–8 (30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Highlights of a first effort in sorting out rare gases in lunar material are solar wind rare gases in abundance; variable $^{20}Ne/^{22}Ne$ but constant $^{21}Ne/^{22}Ne$ ratios in fractions of the trapped neon; cosmogenic rare gases similar to those found in meteorites, except for copious ^{131}Xe in one rock but not in another; at Tranquility Base a rock 4.1×10^9 years old which reached the surface 35 to 65 million years ago, amid soil whose particles have typically been within a meter of the surface for 10^9 years or more. (auth)

21533 SOLAR WIND GASES, COSMIC RAY SPALLATION PRODUCTS, AND THE IRRADIATION HISTORY. Marti, K.; Lugmair, G. W.; Urey, H. C. (Univ. of California, San Diego, La Jolla). Contract NAS 9-8107. Science; 167: 548–50(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The isotopic abundances of the rare gases in the fines were found to be similar to those previously reported for gas-rich meteorites. Relative to the heavy gases, neon and helium are depleted by factors of 2.5 and 10 respectively. Accurate krypton–

krypton ages for rocks 10017, 10047, 10057, and 10071 were obtained covering a range of from 47 to 509 × 10^6 years. Varying relative production rates of the krypton and xenon isotopes in these rocks suggest different irradiation conditions and a complex history for at least some of the rocks. (auth)

21534 ISOTOPIC COMPOSITION OF RARE GASES IN LUNAR SAMPLES. Pepin, R. O.; Nyquist, L. E.; Phinney, Douglas; Black, David C. (Univ. of Minnesota, Minneapolis). Contracts NAS 9-8093; Nonr-710(58). Science; 167: 550-3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Data from total melt and step-by-step heating experiments on the Apollo 11 lunar samples suggest a close affinity between lunar and meteoritic rare gases. Trapped neon-20/neon-22 ratios range from 11.5 to approximately 15, resembling those for the gas-rich meteorites. Trapped krypton and xenon in the lunar fines and in the carbonaceous chondrites are similar except for an interesting underabundance of the heavy isotopes in both lunar gases which suggests that the fission component found in carbonaceous chondrites is depleted in lunar material. Spallation gases are in most cases quite close to meteoritic spallation gases in isotopic composition. (auth)

21535 COSMIC-RAY PRODUCTION OF RARE GAS RADIOACTIVITIES AND TRITIUM IN LUNAR MATERIAL. Stoenner, R. W.; Lyman, W. J.; Davis, R. Jr. (Brookhaven National Lab., Upton, N. Y.). Science; 167: 553-5(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The argon radioactivities ^{37}Ar and ^{39}Ar were obtained by vacuum melting from interior and exterior portions of rock 10057 and from a portion of the fines from the bulk sample container. The release of argon and tritium as a function of the temperature was followed for the fine material. A comparison was made of the activities observed in the lunar samples with those expected from the spallation of iron, titanium, and calcium. From these data and the ^{38}Ar content, the cosmic-ray exposure age of rock 10057 was deduced as 110 × 10^6 years. (auth)

21536 INERT GASES IN LUNAR SAMPLES. Heymann, D.; Yaniv, A.; Adams, J. A. S.; Fryer, G. E. (Rice Univ., Houston, Tex.). Contract NAS-9-7899. Science; 167: 555-8(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Sample 10084,40 (fines, less than 1 millimeter) contains substantial amounts of the inert gases. Their concentrations are inversely proportional to particle size; hence the gases appear to be surface-correlated in the soil fragments. The most likely origin of the gas is solar wind or solar cosmic rays. Glass and feldspar are generally poorer in gas than lithic fragments. Ratios of elements in the sample differ significantly from solar values. Ratios of isotopes in the sample are similar to those in meteorites. Argon-40 appears to consist of a radiogenic and a surface-correlated component. An apparent potassium/argon age of $4.42^{+0.14}_{-0.11}$ billion years is calculated. (auth)

21537 TRAPPED SOLAR WIND NOBLE GASES, ^{81}Kr/Kr EXPOSURE AGES AND K/Ar AGES IN APOLLO 11 LUNAR MATERIAL. Eberhardt, P.; Geiss, J.; Graf, H.; Groegler, N.; Kraehenbuehl, U.; Schwaller, H.; Schwarzmueller, J.; Stettler, A. (Univ., Bern). Science; 167: 558-60(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Grain-size and etching experiments show that the fine lunar material contains large amounts of trapped solar-wind particles. Elemental and isotopic compositions of the noble gases in solar material and in the terrestrial atmosphere are significantly different, except for the ^{36}Ar/^{38}Ar and the Kr isotope ratios. Exposure ages of two rocks and of the fine material are between 380 and 510 × 10^6 years. Feldspar concentrates give K/Ar ages of 3220 and 3300 × 10^6 years, significantly higher than the unseparated rock. (auth)

21538 GAS ANALYSIS OF THE LUNAR SURFACE. Funkhouser, J. G. (State Univ. of New York, Stony Brook); Schaeffer, O. A.; Bogard, D. D.; Zaehringer, J. Contract NAS 9-8820. Science; 167: 561-3(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

The rare gas analysis of the lunar surface has lead to important conclusions concerning the Moon. The large amounts of rare gases found in the lunar soil and breccia indicate that the solar atmosphere is trapped in the lunar soil as no other source of such large amounts of gas is known. The cosmogenic products indicate that the exposure ages of the 17 lunar rocks measured vary from 20 to 400 million years with some grouping of the ages. The most striking feature is the old potassium-argon age which for the 14 rocks analyzed varies from 2.5 to 3.8 billion years. It is concluded that Mare Tranquillitatis crystallized about 4 billion years ago from a molten state produced by a large meteorite impact or volcanic flow. (auth)

21539 SOLID STATE STUDIES OF THE RADIATION HISTORY OF LUNAR SAMPLES. Crozaz, G.; Haach, U.; Hair, M.; (and others) (Washington Univ., St. Louis). Science; 167: 563-6(30 Jan 1979).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Particle track densities up to >3 × 10^9/cm^2 were measured in different samples. Rocks 17, 47, 57, and 58 have VH (Z > 22) galactic cosmic-ray ages of 11, 14, 28, and 13 × 10^6 years, respectively. Rock 57 has a calculated erosion rate of $\lesssim 10^{-7}$ cm/yr. Near-surface track versus depth data in rock 17 can be fit with solar-flare particles that have a differential energy spectrum αE^{-3}; lunar samples can be used to study the history of solar activity. The uranium in the crystalline rocks occurs principally in small regions <10 to ~100 micrometers in size. The (low) thermoluminescence of the fines increases with depth in core 10004. With one possible exception, x-ray studies have not shown pronounced radiation damage effects. The total energy release upon heating is small up to 900°C and occurs in three broad regions. (auth)

21540 TRITIUM AND ARGON RADIOACTIVITIES IN LUNAR MATERIAL. Fireman, Edward L.; D'Amico, James C.; DeFelice, James C. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Science; 167: 566-8(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Tritium and argon radioactivities, attributable to galactic and solar cosmic-ray interactions, were measured in lunar soil and in three lunar rocks. The tritium in the soil, 325 ± 17 disintegrations per minute per kilogram, is slightly higher than that in the rocks, 212 to 250 dpm/kg. For two rocks, the tritium was combined with the ^{3}He in order to calculate exposure ages of 375 ± 40 and 205 ± 25 million years. The ^{37}Ar radioactivities, 21.0 to 27.2 dpm/kg, and the ^{39}Ar radioactivities, 12.1 to 16.4 dpm/kg, are slightly higher than those in stony meteorites. Higher exposure ages were obtained from the argon isotopes than from tritium and ^{3}He. On the basis of the known galactic cosmic-ray flux and the known cross section, at least half of the observed radioactivities are produced by solar cosmic rays. (auth)

21541 PARTICLE TRACK, X-RAY, THERMAL, AND MASS SPECTROMETRIC STUDIES OF LUNAR MATERIAL. Fleischer, R. L.; Haines, E. L.; Hanneman, R. E.; Hart, H. R. Jr.; Kasper, J. S.; Lifshin, E.; Woods, R. T. (General Electric Research and Development Center, Schenectady, N. Y.). Science; 167: 568-71(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Particle tracks in Apollo 11 samples are dominantly of cosmic-ray and solar origin: primary galactic and solar flare particles, likely spallation recoil tracks, and possible solar-wind heavy particles. The energy spectrum of iron-group nuclei is inferred from track density gradients in surface layers, and a limit of $\ll 10^{-7}$ cm/yr is deduced for the surface erosion rate. From cosmic-ray tracks in rock and core samples it is clear that the lunar soil is stirred often during each few million years. X rays reveal augite, anorthite, olivine, ilmenite, troilite, nonmeteoritic iron, and assorted glasses, but no major structural damage. Hydrogen, helium, and other gases in the fines are compatible with expected solar-wind ratios. (auth)

21542 ELEMENTAL COMPOSITIONS AND AGES OF LUNAR SAMPLES BY NONDESTRUCTIVE GAMMA-RAY SPECTROMETRY. O'Kelley, G. Davis (Oak Ridge National Lab., Tenn.); Eldridge, James S.; Schonfeld, E.; Bell, P. R. Science; 167: 580-2(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

A gamma-ray spectrometry system with low background was used to determine the radioactivity of crystalline rocks, breccias, and fine material. Nuclides identified were ^{40}K, ^{232}Th, ^{238}U, ^{7}Be, ^{22}Na, ^{26}Al, ^{44}Ti, ^{46}Sc, ^{48}V, ^{52}Mn, ^{54}Mn, and ^{56}Co. Concentrations of K, Th, and U ranged between 480 and 2550, 1.01 and 3.30, and 0.26 and 0.83 parts per million, respectively. Concentrations of thorium and uranium were those of terrestrial basalts, while the potassium concentrations were near values for chondrites. Products of low-energy nuclear reactions showed pronounced concentration gradients at rock surfaces. Concentrations of K and of ^{22}Na determined were combined with concentrations of rare gases

to estimate gas-retention ages and cosmic-ray exposure ages with ranges of 2200 to 3200 and 34 to 340 million years, respectively, for three rocks. (auth)

21543 PHASE CHEMISTRY, STRUCTURE, AND RADIATION EFFECTS IN LUNAR SAMPLES. Arrhenius, Gustaf; Asunmaa, Saara; Drever, James I.; (and others) (Univ. of California, San Diego, La Jolla). Science; 167: 659-61(30 Jan 1970).
From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Phase chemistry, structure, and radiation effects were studied in rock, breccia, and soil samples. The regolith apparently developed in the final stages of accretion and was modified by later impact processes and radiation weathering. Exposure ages indicate transfer of buried igneous rock fragments to the near surface late in lunar history. With a few exceptions igneous rock fragments, soil, and breccia share the same distinctive chemistry, probably acquired before accretion of the Moon. The igneous rocks texturally resemble basaltic achondrites, and the soil and breccias contain glassy spheres analogous to chondrules. (auth)

21544 LUMINESCENCE AND THERMOLUMINESCENCE INDUCED BY BOMBARDMENT WITH PROTONS OF 159 MILLION ELECTRON VOLTS. Edgington, J. A. (London Univ.); Blair, I. M. Science; 167: 715-17(30 Jan 1970).
From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

A red luminescence, qualitatively similar to that of enstatite achondrites, was observed in unsorted fines, their separated mineral phases, and rock chips. The energy efficiency of the plagioclase fraction is approximately 1%. At −196°C the effect is enhanced by a factor between 1 and 2. All fractions except ilmenite exhibit blue thermoluminescence with a glow peak near −135°C and an energy efficiency $\approx 4 \times 10^{-6}$. Unlike the thermoluminescence of terrestrial and meteoritic material, it is nonrepeatable even after annealing at 200°C. Similar thermoluminescence is seen in rock chips, but in unsorted fines it is masked by the opaque fractions. (auth)

21545 LUMINESCENCE, ELECTRON PARAMAGNETIC RESONANCE, AND OPTICAL PROPERTIES OF LUNAR MATERIAL. Geake, J. E. (Univ. of Manchester, Eng.); Dollfus, A.; Garlick, G. F. J.; Lamb, W.; Walker, C.; Steigmann, G. A.; Titulaer, C. Science; 167: 717-20(30 Jan 1970).

From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Dust samples were found to luminesce weakly under proton excitation, but not under ultraviolet. Damage, recovery, and heating effects were investigated. Chips of breccia show luminescence, from white inclusions only, under ultraviolet and protons. Some rock chips show general luminescence, mainly from plagioclase. No natural or excited thermoluminescence was found for dust or chips. The electron paramagnetic resonance spectrum shows the same broad Fe^{3+} dipole resonance for dust and for some chips; other chips show no response. The polarization characteristics of dust are found to be identical to those of the Sea of Tranquillity, independently of proton damage. Chips show characteristics unlike any part of the lunar surface. (auth)

21546 LUMINESCENCE AND REFLECTANCE OF TRANQUILLITY SAMPLES: EFFECTS OF IRRADIATION AND VITRIFICATION. Nash, Douglas B.; Conel, James E.; Greer, Raymond T. (Jet Propulsion Lab., Pasadena, Calif.). Contract NAS 7-100. Science; 167: 721-4(30 Jan 1970).
From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Luminescence measurements of Tranquillity samples indicate that energy efficiencies for excitation by protons and ultraviolet are in the range 10^{-6} or below; natural and induced thermoluminescence is even weaker. If these samples are typical, lunar surface luminescence cannot occur at reported levels. Comparison of proton luminescence spectra from the exterior and interior of rocks and fine fragments provides evidence of solar-wind impingement on the moon's surface. Spectral reflectance and albedo measurements of fresh rock powders before and after both laboratory proton irradiation and fusion indicate that vitrification may be an important mechanism of lunar darkening. (auth)

21547 SOLAR RADIATION EFFECTS IN LUNAR SAMPLES. Hapke, B. W.; Cohen, A. J.; Cassidy, W. A.; Wells, E. N. (Univ. of Pittsburgh). Contract NAS 9-9942. Science; 167: 745-7(30 Jan 1970).
From Apollo 11 Lunar Science Conference, Houston, Tex. See CONF-700106.

Optical properties of the pulverized crystalline rocks from the Apollo 11 samples are different from the optical properties of lunar soil. Changes in these properties were induced in the samples by ultraviolet and x irradiation, standing, and heating. The albedo and spectrum of the soil differed significantly from expected values. (auth)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

21548 INVESTIGATION OF THE INTERACTION PROCESSES OF ACCELERATED T^+ IONS IN SOLID TARGETS BY THE METHOD OF INTERLAYER IRRADIATION. Firsova, L. P.; Marav'ev, V. V.; Kapitanchuk, V. A. Radiokhimiya; 11: 711-15 (1969). (In Russian).

The method of interlayer irradiation of solid targets by ion bundles makes it possible to evaluate the drift of slowed tritium ions to chemical stability and to obtain information on the chemical reactions of high-energy atoms. (tr-auth)

21549 HOT ELECTRON SCATTERING AND OPTICAL DENSITY OF STATES OF YTTRIUM. Eastman, Dean E. (IBM Watson Research Center, Yorktown Heights, N. Y.). Solid State Commun.; 8: 41-4(Jan 1970).

The mean free path of hot electrons in Y was determined to be ~10 Å at 7 eV above the Fermi level E_F by a new photoemission method. The importance of this strong electron−electron scattering in photoemission spectroscopy work is shown via an analysis of the optical density of states of Y. An occupied d band is found with a peak at E_F and a width of 1.6 ± 0.2 eV (at ½ maximum). (auth) (UK)

Atomic and Molecular Properties

21550 (UUIP-626) ESCA STUDIES OF OUTER LEVELS IN RARE EARTH ATOMS. Nilsson, Oe.; Bergmark, J.-E.; Thoren, I. (Uppsala Univ. (Sweden). Inst. of Physics). Mar 1969. 11p. Dep. CFSTI (U. S. Sales Only).

Determinations of binding energies in rare earth elements are presented. The 4s, 4p, and 4d levels and the valence band structure were considered. Considerable deviations between the present experimental values and earlier tabulated binding energies were obtained. (auth) (Sweden)

21551 (UUIP-635) ELECTRON BINDING ENERGIES IN PROMETHIUM. Malmsten, G.; Nilsson, Oe.; Thoren, I.; Bergmark, J.-E. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1969. 8p. Dep. CFSTI (U. S. Sales Only).

L, M and N electron binding energies in Pm were determined by electron spectroscopy for chemical analysis. The Pm isotope used in the photoelectron measurements was ^{147}Pm, which is β^--active with a half-life of 2.6 years. The Pm activity was deposited (3×15 mm^2) onto an aluminum foil by the method of molecular plating, with acetone as the plating liquid. This procedure gives the Pm specimen in the form of a metal organic complex with several hydrogen, carbon, and oxygen atoms included. The photoelectrons were expelled by characteristic Al, Cu, or Mo x radiation and detected by an array of five side-slit channel electron multipliers. When studying the photoelectrons from the $4p_{\frac{1}{2}}$ and 4d levels, Al $K\alpha_{1,2}$ was used for excitation. The 3s, 3p, 3d, 4s and 4p levels were studied with Cu $K\alpha_{1,2}$ radiation. Each of the Cu $K\alpha$ lines has a width of ~2 eV and an energy of ~8 keV, giving somewhat less precision in the energy determination than with the Al radiation. (auth) (Sweden)

21552 COMPUTATION OF WAVE FUNCTIONS FOR THE HELIUM ISOELECTRONIC SEQUENCE. Knox, H. O. (Queen's Univ., Belfast). Comput. Phys. Commun.; 1: 167-80(Jan 1970).

A program is described for the computation of wave functions and energies of the helium isoelectronic sequence to any desired accuracy. These wave functions have the correct asymptotic form and are particularly suitable for use in scattering problems. (J.F.P.)

21553 INTERPOLATION BETWEEN SLATER'S AND KOHN–SHAM'S EXCHANGE APPROXIMATIONS. Zelenka, J. (Inst. of Metallic Materials, Bratislava); Suffczynski, M. Czech. J. Phys., 19B: 1199-1203(1969).

An interpolation scheme between Slater's and Kohn−Sham's exchange approximations is proposed. This scheme gives the orbitals for atomic Cu^+ and Zn close to those of the Hartree−Fock method. (auth)

21554 HYPERFINE STRUCTURE IN Tb II AND NUCLEAR MOMENTS OF ^{159}Tb. Dekker, J. W. M.; Bloemhof, H. F.; Brouwer, J. H.; Klinkenberg, P. F. A. (Univ., Amsterdam). Physica; 46: 119-32(23 Feb 1970).

The hyperfine structure in some Tb II lines was recorded by means of a Fabry–Perot spectrometer of the "hypeac" type, with digital output. Computer analysis of the patterns made it possible to locate off-diagonal transitions so that the structure of the levels could be established. From the structure of the level $4f^9\ 6s\ ^7H_3$, the spectroscopic nuclear electric quadrupole moment of ^{159}Tb is found to be $Q_s = 1.18$ barn if a value of $\langle r_4^{-3} \rangle$ is used, which is consistent with current knowledge of the rare-earth systems. This is discussed in the light of recent radio-frequency observations in an atomic beam by Childs and Goodman (J. Opt. Soc. Amer., 59: 875(1969)). (auth)

21555 THEORY OF ATOMIC LIFETIME MEASUREMENTS. Macek, Joseph (Univ. of Nebraska, Lincoln). Phys. Rev., A; 1: 618-27(Mar 1970).

The theory of atomic lifetime measurements is developed on the basis of the quantum theory of radiation. The effect of coherent emission on the shape of the decay curves is studied in detail. It is shown that the light intensity will oscillate in time when two closely spaced levels decay coherently. Oscillations due to interference between fine-structure levels of the hydrogen atom in particular are discussed. (auth)

21556 DOUBLE PHOTOIONIZATION OF HELIUM. Brown, Robert L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Phys. Rev., A; 1: 586-90(Mar 1970).

The helium double-photoionization cross section was evaluated using a Hylleraas wave function for the ground state in order to include correlation between the atomic electrons more directly than in previous calculations. Good agreement is found between the present results, the experimental data, and the theoretical work of Byron and Joachain. An interpretation of the differential electron spectrum is used to motivate an asymptotic calculation of the double-photoionization cross section, which agrees well with the more exact treatment at high energies. (auth)

21557 HYPERFINE STRUCTURE OF THE 2^3S_1 STATE OF ^3He. Rosner, S. D.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 1: 571-86(Mar 1970).

The zero-field hyperfine structure of the metastable 2^3S_1 state of ^3He was measured by the optical pumping magnetic resonance method. The hyperfine transitions in a weak magnetic field were observed at low temperature in order to achieve narrow linewidths. Discussions of the theory of the hyperfine structure, the theory of the experiment, the apparatus, and the experimental procedure are presented. The final value for the hyperfine structure is 6, 739, 701, 177 ± 16 Hz on the A-1 time scale. The fractional pressure shift of the hyperfine structure is $(-7.4 \pm 3.0) \times 10^{-9}$/torr. The theoretical and experimental values for the hyperfine structure are compared, and the dependence on the nuclear structure is discussed. (auth)

21558 HYPERFINE-STRUCTURE ANOMALIES OF STABLE YTTERBIUM ISOTOPES. Budick, B.; Snir, J. (Hebrew Univ., Jerusalem). Phys. Rev., A; 1: 541-51(Mar 1970).

Hyperfine-structure anomalies of the stable ytterbium isotopes ^{171}Yb ($I = 1/2$) and ^{173}Yb ($I = 5/2$) were measured in the two lowest-lying $^3P_1$ states of the Yb atom. For the $(4f)^{14}6s6p\ ^3P_1$ level $\Delta = -0.367(9)\%$, while for the $(4f)^{13}5d(6s)^2\ ^3P_1$ level $\Delta = +0.084(22)\%$. The former result is the first conclusive evidence that the Nilsson model can account for the distribution of nuclear magnetism in highly deformed nuclei. The second result, in conjunction with the first, can be used to establish the amount of unpaired s-electron spin density in a state explicitly lacking in unpaired s electrons. If other forms of configuration interaction are neglected, it is calculated that the core-polarization magnetic field produced by the 5d electron at the nuclear site is -1.7×10^5 G. Byproducts of this work were the lifetimes of the two excited electronic states. It was found that $\tau(6s6p\ ^3P_1) = 7.6(8) \times 10^{-7}$ sec and $\tau(f^{-1}\ ds^2\ ^3P_1) = 1.7(2) \times 10^{-8}$ sec. (auth)

21559 RKR POTENTIAL AND MORE ACCURATE DISSOCIATION ENERGY OF $He_2(A^1\Sigma_u^+)$. Smith, Allan Laslett; Chow, K. W. (Yale Univ., New Haven). J. Chem. Phys.; 52: 1010-12(15 Jan 1970).

It is suggested that the disagreement between values of the dissociation energy of $He_2(A^1\Sigma_u^+)$ obtained in recent studies of vacuum-ultraviolet emission and absorption is due to the vibrational numbering assumed. Information from these two experiments is combined with the data of Ginter (J. Chem. Phys., 42: 561 (1965)) to renumber the vibrational states observed in absorption. The constants $B_{v'}$ and $G_{v'}$ are then determined for all the 17 bound states in the potential well; from these an RKR potential is computed. From this potential a value of the dissociation energy of 2.345 ± 0.015 eV is computed. (A.G.W.)

21560 SPECTRUM OF DOUBLY IONIZED THULIUM (Tm III). Sugar, Jack (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer.; 60: 454-66(Apr 1970).

A list of 848 low-excitation spectral lines of Tm III was obtained by utilizing the sliding-spark light source at a peak current of 6 A. An analysis of these lines yielded 108 energy levels belonging to the configurations $4f^{13}$, $4f^{12}5d$, $4f^{12}6s$, and $4f^{12}6p$. The classified lines and level values are presented as well as a theoretical interpretation of these configurations. (auth)

21561 CONFIGURATION $4f^{12}5d$ OF DOUBLY IONIZED YTTERBIUM. Sugar, Jack (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer.; 60: 571-2(Apr 1970).

Corrections suggested by Sack (Phys. Rev., 102: 1302(1956)) were used to recalculate the levels of the $4f^{13}5d$ configuration of doubly ionized ytterbium from the data of Bryant (J. Opt. Soc. Amer., 55: 771(1965)). One level that showed a conspicuously large deviation was discarded. These changes resulted in a reduction of the rms error for the level calculations from 241 cm^{-1} for the original calculations to 60 cm^{-1}. A possible substitute for the discarded line is suggested. (A.G.W.)

21562 PROPOSED SECONDARY-STANDARD WAVELENGTHS IN THE SPECTRUM OF THORIUM. Giacchetti, A. (Argonne National Lab., Ill.); Stanley, R. W.; Zalubas, R. J. Opt. Soc. Amer.; 60: 474-89(Apr 1970).

Energy levels for Th I were computed from the weighted averages of wavelengths from seven sets of published interferometrically measured data. The most self-consistent energy levels obtained in this way were then employed to calculate wave numbers that have a standard deviation of less than 10 mK. It is proposed that these lines be adopted as class-B secondary standards. Calculated wavelengths of 1375 Th I lines and weighted averages of 181 interferometrically measured Th I and Th II lines between 2565 and 12 381 Å are given. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

21563 (NAL-37) X RAYS FROM MUON, PION, KAON, AND SIGMA-MINUS CAPTURE IN THE LIGHT ELEMENTS. Berezin, S.; Burleson, G.; Eartly, D.; Roberts, A.; White, T. O. (National Accelerator Lab., Batavia, Ill.). Dec 1969. 80p. Dep. CFSTI.

A search for x rays from the capture of kaons in helium has disclosed neither K- nor L-series radiation; the upper limit of the x-ray yield is in the range 7 to 10 percent. This contradicts results of an earlier measurement but is in better agreement with related data on kaon–helium scattering. In the same experimental arrangement, the yields of pionic and muonic x rays in helium were also measured. Anomalously low yields were found, accompanied by intensity distributions of the K-series members in disagreement with the conventional cascade picture of a predominantly circular set of orbits. Monte Carlo cascade calculations could not duplicate the observed results unless weak Stark mixing, in the form of "sliding transitions" $(n,l \rightarrow n,l \pm 1)$ was added. Agreement with observation was achieved in muonic, pionic, and kaonic atoms with a single value for the parameter describing the strength of the Stark mixing. Yields and energies of kaonic x rays in other light elements, Li, Be, and C, were also measured. Yields of x rays from muonic and pionic capture in these elements were remeasured also, and cascade calculations like those for helium repeated. In these elements the addition of Stark mixing is not needed to achieve agreement with experiment. In the pionic atoms 2p-state absorption rates, and in kaonic atoms 3d-state absorption rates for He, Li, Be, and C can be derived from the experimental data and compared with theoretical values, with good agreement. In addition to the identifiable kaonic transition lines also observed by Wiegand and Mack, additional lines not ascribable to kaonic atoms were found in all three elements. After careful consideration of possible origins of these lines, the two lithium lines are ascribed to M_α and M_β, and the Be line to M_α transitions in sigma-hyperonic atoms. Such atoms are formed if Σ^- hyperons from kaon capture (whose abundance is about 15%) are slowed down and stopped in the target. The observed yields and energies are consistent with this interpretation, and with no other known at present. A line in C, however, cannot be ascribed either to kaonic or sigma atoms, and appears to be a pionic L_α. Why such a line appears only in C is not understood. (auth)

21564 EFFECTS OF POSITRON–PHONON INTERACTION IN METALS. Mikeska, Hans-Juergen (Institut Max von Laue-Paul Langevin, Garching, Ger.). Z. Phys.; 232: 159-73(1970).

The importance of positron–phonon interaction for the many-body effects observed in positron annihilation in metals is investigated. The interaction is formulated as the screened Coulomb interaction of the positron with the polarization charge of the metal produced by lattice vibrations. The phonon contribution to the effective mass is found to be negligibly small. Due to the interaction

with phonons, the equilibrium positron momentum distribution deviates from a Boltzmann distribution, leading to a larger thermal smearing of the annihilation curves than expected from the rather small effective mass. The positron energy loss in the thermalization process due to phonon excitation is discussed and found comparable to the energy loss due to the excitation of electron–hole pairs in the experimentally interesting temperature range. (auth)

21565 STRUCTURE OF NEUTRAL MESONIC ATOMS FORMED IN LIQUID HELIUM. Russell, J. E. (Oxford Univ. Univ. of Cincinnati). Phys. Rev., A; 1: 721-34(Mar 1970).

Wave functions and binding energies are calculated for some states of the $\alpha\pi^-e^-$, αK^-e^-, and $\alpha\bar{p}e^-$ atoms in which the electron is in a 1s orbit and in which the meson or the antiproton is in a circular or a nearly circular orbit with large principal quantum number n. The results obtained in the present paper provide a basis for an estimate, described elsewhere, of the probability that atoms in some of these states can exist for an anomalously long time after being formed in liquid helium. Two methods are employed to calculate the wave functions and binding energies. A variational method that employs hydrogenic functions is used for states in which the meson is in a circular orbit. A more elaborate method, which makes use of the Born–Oppenheimer approximation and which is applicable to states with meson orbits that are not necessarily circular, is used for circular and nearly circular orbits of a few levels of the $\alpha\pi^-e^-$ and αK^-e^- atoms. It is found, in particular, that an E4 or higher multipole transition is required for an Auger electron to be ejected by a K^- meson in a circular orbit of the αK^-e^- atom with n = 27, 28, or 29. It is found that for levels of the αK^-e^- atom with n = 27, 28, or 29 the magnitude of the energy difference between two states with the same value of n, but with orbital angular momenta (n−2) and (n−1), is roughly 0.5 eV. It is also found that, in some instances, replacing the absolute square of the meson wave function with a δ function does not significantly affect the accuracy of a calculation. (auth)

21566 MUONIUM. I. MUONIUM FORMATION AND LARMOR PRECESSION. Hughes, Vernon W. (Yale Univ., New Haven); McColm, Douglas W.; Ziock, Klaus; Prepost, Richard. Phys. Rev., A; 1: 595-617(Mar 1970).

A complete quantitative discussion is given of the experiments in which muonium was discovered through studies of the depolarization of muons in gases and of the Larmor precession of muonium in argon in a static magnetic field. Also described are the observation of the hfs interval $\Delta\nu$ of muonium in its ground state and the determination of $\Delta\nu$ to an accuracy of about 50% through the use of a static magnetic field. A theoretical discussion is given of muonium formation in gases, including polarization effects. The experimental results on the Larmor precession of muonium prove that close to 100% of the muons stopping in pure argon gas form muonium. The experimental results on muon depolarization in other gases, together with the theoretical considerations, suggest that abundant muonium formation should occur when muons are stopped in most gases; the case of SF_6 appears anomalous in that, at most, only small formation of muonium is indicated. A discussion of the energy levels and decay characteristics of muonium is given. This is the first in a series of papers on the muonium atom and on its interactions in gases. (auth)

21567 DISTORTION OF THE ELECTRON WAVE FUNCTION IN $\alpha\pi^-e^-$, αK^-e^-, AND $\alpha\bar{p}e^-$ ATOMS. Russell, J. E. (Univ. of Cincinnati). Phys. Rev., A; 1: 735-42(Mar 1970).

An investigation is made of the extent to which the binding energies and wave functions for some states of the $\alpha\pi^-e^-$, αK^-e^-, and $\alpha\bar{p}e^-$ atoms are affected by the dipole and higher multipole interactions of the electron with the meson or the antiproton. The meson or antiproton is treated as a classical point charge. Perturbation theory is employed to determine the admixture of discrete excited states of the unperturbed electron Hamiltonian. The unperturbed electron Hamiltonian takes into account only the monopole interaction of the electron with the meson. A variational method is employed to determine approximately the change in the binding energy as well as some of the more important features of the distortion of the electron wave function. It is found, in particular, that the binding energies of those states of the αK^-e^- atom in which the meson is in a circular orbit with principal quantum number n = 27, 28, or 29 are lowered by slightly less than 1 eV. The maximum relative change in the amplitude of the electron wave function for one of these states is found to be roughly 20%. (auth)

21568 AUGER RATES FOR CIRCULAR ORBITS OF $\alpha\pi^-e^-$, αK^-e^-, AND $\alpha\bar{p}e^-$ ATOMS. Russell, J. E. (Oxford Univ., Univ. of Cincinnati). Phys. Rev., A; 1: 742-50(Mar 1970).

Auger rates are estimated for some circular orbits of the $\alpha\pi^-e^-$, αK^-e^-, and $\alpha\bar{p}e^-$ atoms. It is found, as conjectured by Condo several years ago, that the Auger rate for a circular orbit depends sensitively on the multipolarity of the transition. In some instances, the multipolarity may be required by energy conservation to be large enough to permit a π^- or a K^- meson to decay rather than to eject an electron. In particular, the estimated Auger rates for those circular orbits of the $\alpha\pi^-e^-$, αK^-e^-, and $\alpha\bar{p}e^-$ atoms with binding energies most nearly equal to that of a He atom are, respectively, 2×10^{12}, 4×10^{5}, and $\lesssim10^{3}$ sec^{-1}. Radiative rates are also computed. (auth)

21569 POSITRON ANNIHILATION IN CONCENTRATED CESIUM–AMMONIA SOLUTIONS. Arias-Limonta, Jose A.; Varlashkin, Paul G. (Louisiana State Univ., Baton Rouge). J. Chem. Phys.; 52: 581-5(15 Jan 1970).

The momentum distribution of photons from positrons annihilating in liquid and solid cesium–ammonia solutions was found to be concentration-dependent. The narrow component was found to broaden with increasing concentration. The results are compared with those obtained for pure cesium, and one is led to believe that a bound species is formed in these solutions even at very high concentrations. No evidence of a Mott transition is found in cesium–ammonia solutions, and no abrupt change is found in the shape of the momentum distribution in going from 22 to 94 mole % cesium in ammonia. A conduction-electron-type analysis is presented for the density of states and the probability density. Methods of preparing relatively stable cesium–ammonia solutions are discussed in some detail. (auth)

21570 STUDY OF INHIBITION AND QUENCHING OF POSITRONIUM BY IODINE AND CCl_4. Chuang, S. Y.; Tao, S. J. (New England Inst., Ridgefield, Conn.). J. Chem. Phys.; 52: 749-51(15 Jan 1970).

Positron annihilation time spectra on various concentration of iodine and CCl_4 adsorbed in silica gels were studied. It was found that iodine acts as a chemical quencher to positronium, and CCl_4 acts as an inhibitor to the formation of positronium. (auth)

21571 POSITRONIUM AND IODINE REACTIONS IN ORGANIC SOLVENTS. Tao, S. J. (New England Inst., Ridgefield, Conn.). J. Chem. Phys.; 52: 752-7(15 Jan 1970).

The quenching of o-Ps by iodine in various organic solvents is investigated. It is found that iodine acts as both a chemical quenching agent and a Ps formation inhibitor. The reaction between Ps and iodine is diffusion-controlled. The annihilation lifetime of the formed Ps iodine compound (PsI_2 or PsI) is estimated to be 0.4 nsec. The inhibition coefficient is calculated to be 20 $mole^{-1}$ for iodine in hydrocarbon solvents and 5.0 $mole^{-1}$ in oxyhydrocarbon solvents. After an investigation the high Ps quenching rates in iodine solutions cannot all be attributed to high values of the diffusion coefficient. The interaction between Ps and iodine must also be taken into consideration. Obviously, the formation of the charge-transfer complex of iodine plays an important role here. (auth)

21572 EMISSION OF POSITRONIUM. Vlasov, N. A. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 201-2(Sep 1969).

Translated from Opt. Spektrosk.; 27: 377-9(Sep 1969).

An experimental optical investigation of positronium photons emitted in transitions from excited states is proposed. The conditions for the formation of positronium and the main features of the construction of a positronium emission source are discussed. The possibility of tuning the source by observing the annihilation in the metastable state with a lifetime of 1.1×10^{-6} sec is pointed out. (auth)

Collision Phenomena

Refer also to abstract 21780.

21573 MULTIPLE EXCITATION OF A MANY-ELECTRON SYSTEM BY PHOTON AND ELECTRON IMPACT IN THE SUDDEN APPROXIMATION. Aberg, Teijo (Technical Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI; No. 308, 1-46(1969).

Atomic correlation is introduced in the sudden-approximation treatment of excitation accompanying ionization of a many-electron system. The relationship between the first Born approximation and the sudden approximation is shown. In the case of photon impact both approximations yield, in the high-energy limit, identical relative multiple-excitation cross sections for an arbitrary initial-state wave function, provided that the velocity form but not the length form of the Born cross section is used. In the case of electron impact this equality is valid in general only if the correlation in the initial state between the knocked-out electron and the other electrons is weak. The sudden approximation calculations made are found to be in agreement with photon impact experiments for both strong (KK excitation of the helium atom) and weak (KL and KL^2 excitation of various atoms and ions) correlation. Agreement with electron-impact experiments is found for weak (KL excitation).

correlation, but there is disagreement in the case of KK ionization of the helium atom bombarded by charged particles. (auth)

21574 SOME THREE-BODY ATOMIC SYSTEMS. McGowan, J. William (Univ. of Western Ontario, London. Gulf General Atomic, San Diego, Calif.). Science; 167: 1083-92(20 Feb 1970).

Experimental and theoretical research on the three-body systems involved in the collision of an electron with a hydrogen atom or a helium ion (He^+) is reviewed. Emphasis is on the formation of electron scattering resonances and on the details of ionization and excitation in the energy interval near threshold. It is concluded that, though it is still impossible to solve the three-body problem exactly, the close-coupling and the Faddeev approximations describe most of the details of the elastic and inelastic scattering resonances and inelastic scattering thresholds thus far experimentally examined. Areas still not understood and possible directions for future experiments are considered briefly. 62 references. (A.G.W.)

21575 ONE-DIMENSIONAL FLOW IN THE MPD CHANNEL. Bartl, Josef (Vysoke Uceni Technicke, Brno). Pr. Inst. Masz. Przeply.; No. 46, 79-101(1969).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680555.

Results are presented of the calculation of the optimum efficiencies of power output with regard to inlet parameters (i.e., p_0, T_0, M_1), operating parameters (i.e., K, B, T_w), and exit parameters (i.e., Mach number, pressure, length) of the ideal Faraday-type MPD electrical power generators with segmented-electrode pairs and operating under various conditions. A comparison of the results showed that the constant-temperature-and-pressure generator, within the investigated region of stagnation parameters, is superior to all types of MPD generators studied. It should be emphasized that the calculations were done only for a thermal input of 1 MW (corresponding flow rate about 0.385 kg/sec). Despite the relatively low efficiency of constant-cross-section MPD generators, this type is very useful for an experimental investigation because of its simple construction. For illustration, the variations of some parameters along the generator length for a generator length of L = 2 m operating at $T_0 = 2700°K$, $p_0 = 3 \times 10^5$ N/m^2, B = 2.5 Wb/m^2, K_{opt} and M_{1opt} are given. (auth)

21576 DIFFERENTIAL AND INTEGRAL CROSS SECTIONS FOR EXCITATION OF THE 2^1P STATE OF HELIUM BY ELECTRON IMPACT. Truhlar, Donald G. (California Inst. of Tech., Pasadena); Rice, James K.; Kuppermann, Aron; Trajmar, S.; Cartwright, D. C. Phys. Rev., A; 1: 778-802(Mar 1970).

Differential scattering cross sections for excitation of helium by electron impact from its ground state to its 2^1P excited state were measured at four incident electron energies in the range 26 to 55.5 eV for scattering angles between 10° and 70°, and at 81.6 eV for scattering angles between 10° and 80°. These differential cross sections were placed on an absolute scale by normalizing them to the experimental absolute integral cross sections of Jobe and St. John. These experimental differential and integral cross sections were compared with the results predicted by the Born approximation, and by several other first-order approximations in which direct excitation is calculated in the Born approximation and exchange scattering by various Ochkur-like approximations. The calculations provide reliable tests of these scattering theories since they are made using the accurate generalized oscillator strengths of Kim and Inokuti. As expected, these first-order theories are poor near threshold and exchange is important at high scattering angles for all energies. Further, the absolute magnitude of the calculated integral and small-angle differential cross sections is too large and is within 50% of experiment only at energies greater than 80 eV. These first-order models are in qualitative agreement with the experimental angular dependence at 34 to 81.6 eV for scattering angles between 10° and 40°. At higher scattering angles (corresponding to momentum transfers greater than about 1.6 a.u.), the calculated differential cross sections fall well below the experimental ones. The phase between the direct and exchange scattering amplitudes was found to be important at all energies and is apparently not predicted correctly by any of the first-order models examined here. Some approximations for the exchange (e.g., Ochkur approximation and the post interaction form of the Ochkur–Rudge approximation) were found to be better for integral cross sections and some (e.g., prior Ochkur–Rudge approximation) were better for differential cross sections. The use of good analytic self-consistent-field (SCF) wave functions for both the ground and excited states was tested by computing generalized oscillator strengths from them and comparing these results with the calculations using the accurate generalized oscillator strengths. The SCF functions yield differential cross sections in quantitative disagreement (20%) with the accurate results, although the energy and angle dependence of the cross sections is predicted qualitatively correctly. (auth)

21577 IONIZATION OF FAST He^0 IN THE TRIPLET METASTABLE STATE. Miers, R. E.; Anderson, L. W. (Univ. of Wisconsin, Madison). Phys. Rev., A; 1: 819-21(Mar 1970).

Cross sections were measured for production of He^+ ions by the collision of 10 to 30-keV ^{0}He atoms in the triplet metastable state with target atoms of Xe, Kr, H_2, N_2, Ar, Ne, and He. Fast ^{0}He atoms are produced in the first of two gas targets in which various neutralizer gases may be present at low density. The fractions of ^{0}He produced in the triplet metastable state in these various neutralizer gases are known. The fraction of fast He^+ emerging from a second target containing Xe, Kr, H_2, N_2, Ar, Ne, or He is analyzed as a function of the density of the second gas target, and the cross sections for ionization of ^{0}He atoms from the metastable triplet state are determined. Typical values of the cross sections at 30 keV are 110 ± 40, 37 ± 17, 122 ± 58, 86 ± 42, 18 ± 12, and 65 ± 31 in units of 10^{-17} cm^2 for gas targets of Xe, Kr, H_2, N_2, Ar, Ne, and He, respectively. (auth)

21578 MEASUREMENTS OF Q VALUES FOR N^+–Ar AND O^+–Kr COLLISIONS BY THE COINCIDENCE TECHNIQUE. Knystautas, E. J.; Kessel, Q. C.; Del Boca, R.; Hayden, H. C. (Univ. of Connecticut, Storrs). Phys. Rev., A; 1: 825-33(Mar 1970).

Inelastic energy (Q) profiles and ionization probabilities are measured for N^+–Ar and O^+–Kr collisions using the coincidence techniques of Kessel and Everhart. Incident-ion energies from 10 to 150 keV and scattering angles from 9° to 40° for N^+–Ar collisions, and from 25 to 230 keV and 10° to 40° for O^+–Kr collisions, are studied. The range of average Q values ($\bar{Q}$) is from about 100 eV to about 1 keV for both cases. The average number of electrons lost in the collision varies from about 0.6 to 1.3 for nitrogen and from 3.3 to 4.6 for argon in the N^+–Ar collisions. For the O^+–Kr collisions, the ranges are zero to 1.7 and 2.6 to 6.6 for oxygen and Kr, respectively. For N^+–Ar collisions, a plot of $\bar{Q}$ versus the distance of closest approach shows an abrupt increase of about 115 eV at about 0.15 Å. A study of the natural linewidths of the coincidence profiles indicates the presence of unresolved structure in this vicinity. For the O^+–Kr collisions, $\bar{Q}$ was found to depend on both the distance of closest approach and the collision velocity, but not strongly on the scattering angle at higher energies. (auth)

21579 CROSS SECTION FOR ELECTRON-IMPACT EXCITATION OF THE (0,0) FIRST NEGATIVE BAND OF N_2^+ FROM THRESHOLD TO 3 keV. Borst, W. L.; Zipf, E. C. (Univ. of Pittsburgh). Phys. Rev., A; 1: 834-40(Mar 1970).

The cross section for the excitation of the (0,0) first negative band of N_2^+ by electron impact was measured, using photon-counting techniques, in the energy range from threshold to 3 keV and extrapolated to 10 keV by means of a Bethe–Oppenheimer relation. In order to avoid polarization effects, the primary measurements were made at the "magic angle" of 54° 44′; complementary measurements at 90° were also obtained for comparison purposes. The excitation cross section for the (0,0) band reached its maximum value at an energy of about 100 eV where it was (1.74 ± 0.17) × 10^{-17} cm^2. The ratio of the total ionization cross section to the excitation cross section was nearly constant over the energy range from 30 eV to 10 keV, and had a value of 14.1. (auth)

21580 STUDY OF THE PRODUCTION OF K X RAYS IN Ca, Ti, AND Ni BY 2- TO 28-MeV PROTONS. Bissinger, G. A.; Joyce, J. M.; Ludwig, E. J.; McEver, W. S.; Shafroth, S. M. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.). Phys. Rev., A; 1: 841-7(Mar 1970).

Using a proportional counter as an x-ray detector, thin-target yields, as well as K x-ray production and ionization cross sections, were determined for Ca, Ti, and Ni when bombarded with 2- to 28-MeV protons. Broad maxima in the cross sections were found at approximately 8.5, 10.4, and 16.6 MeV for Ca, Ti, and Ni, respectively, in agreement with theoretical calculations based on the Bethe–Born approximation. The shape of the cross-section-versus-bombarding-energy curve agrees well with theory. However, the absolute values of the cross sections were observed to be higher than predicted by theory when the generally accepted value for the effective charge (Z–0.3) was chosen. (auth)

21581 MULTISTATE IMPACT-PARAMETER CALCULATION OF ATOM–ATOM EXCITATION CROSS SECTION: EXCITATION OF ATOMIC HYDROGEN BY NEON, ARGON, AND KRYPTON. Levy II, Hiram (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev., A; 1: 750-4(Mar 1970).

Excitation cross sections for the collisions H(1s) + Ne, Ar, Kr → H(2s, $2p_0$, $2p_\pm$) + Ne, Ar, Kr are calculated over the velocity range of 0.3 to 5.0 a.u. in the distorted-Born, two-state (for argon only), and four-state impact-parameter approximations that do not allow for electron exchanges between the colliding atoms. The results are compared with earlier first-Born and scaled first-Born calculations and with experimental data. The four-state cross sections,

while greatly reduced from the first Born results, are still between three and ten times greater than experiment. Polarization fractions are also calculated from the four-state cross sections and compared with experimental data and with previous calculations. (auth)

21582 ENERGY-LOSS SPECTRA AND COLLISION CROSS SECTIONS FOR IMPACT OF 20- TO 120-keV POSITIVE IONS ON MOLECULAR NITROGEN. Schowengerdt, F. D.; Park, John T. (Univ. of Missouri, Rolla). Phys. Rev., A; 1: 848-55(Mar 1970).

Inelastic energy-loss spectra induced by impact of H^+, H_2^+, and Ar^+ on N_2 were measured at incident ion energies of 20 to 120 keV, with an energy resolution of about 2 eV. Prominent peaks are observed at energy losses of 9.5 and 13.8 eV. The first of these is well resolved and is attributed to excitation of the Lyman–Birge–Hopfield (LBH) system of N_2. The peak at 13.8 eV is believed due primarily to excitation of the $b^1\pi_u$ band of the Worley–Jenkins series. The locations of these features on the energy-loss scale do not agree with results of the electron impact work of others and, in general, show trends with projectile velocity that are consistent with an assumed enhancement of excitation to higher vibrational states with the heavier particles. Collision cross sections for excitation of the two peaks are presented, as well as the total ionization cross section and the cross section for total inelastic processes in the case of proton impact. (auth)

21583 MANY-BODY THEORY OF THE ELASTIC SCATTERING OF ELECTRONS FROM ATOMS AND MOLECULES. Schneider, Barry (Univ. of Southern California, Los Angeles); Taylor, Howard S.; Yaris, Robert. Phys. Rev., A; 1: 855-67 (Mar 1970).

A method for calculating the elastic scattering of electrons from atoms and molecules using the many-body Green's-function techniques of Martin and Schwinger is presented. The procedure involves the self-consistent solution of a pair of equations; one for the one-particle Green's function and the other for the response function of the target in the time-dependent Hartree–Fock approximation (random-phase approximation). That both equations are one-dimensional provides a great computational advantage over more conventional techniques. The physical nature of the approximation and a numerical scheme to implement the theoretical discussion are discussed. (auth)

21584 CASE STUDIES IN ATOMIC COLLISION PHYSICS. I. McDaniel, E. W.; McDowell, M. R. C. (eds.). New York; John Wiley and Sons, Inc. (1969). 604p. $35.00.

A separate abstract was prepared for each of the nine chapters in the book. (A.G.W.)

For abstracts of individual chapters see: 21585–21592 and 21787.

21585 DRIFT TUBE STUDIES OF THE TRANSPORT PROPERTIES AND REACTIONS OF SLOW IONS IN GASES. McDaniel, Earl W. (Georgia Inst. of Tech., Atlanta). pp 1-46 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

A review of general aspects of the motion of slow ions through gases and classical and quantum mechanical theories of ionic mobility is followed by discussion of drift-tube measurements of drift velocities, diffusion coefficients, reaction rate coefficients, and binding energies of molecular ions. Basic techniques for each kind of measurement, experimental apparatus, and mathematical analysis of the data are considered. The measurements are illustrated by description of experiments on nitrogen ions in nitrogen. 50 references. (A.G.W.)

21586 PHOTOIONIZATION AND IONIZATION OF THE ALKALI METALS. McDowell, M. R. C. (Goddard Space Flight Center, Greenbelt, Md.). pp 47-97 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

The available experimental and theoretical information on ionization of alkali metals by photons and by electrons is reviewed. It is concluded that, for photoionization of Li and Na from threshold to about 900 Å, there is good agreement between experiment and theories that take account of correlation effects. Discrepancies between theory and experiment in the case of electron-impact ionization are pointed out and possible causes are discussed. 67 references. (A.G.W.)

21587 THE IMPULSE APPROXIMATION AND RELATED METHODS IN THE THEORY OF ATOMIC COLLISIONS. Coleman, J. P. (Univ. of Durham, Eng.). pp 99-167 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

Two approximations used in atomic collision calculations, the quantum mechanical impulse approximation and an approximation proposed by Vainshtein in 1963, are reviewed. The evolution of both methods is described, and particular attention is given to the errors and over-simplifications that have been detected and rectified and the shortcomings that still remain. It is shown that both methods may be regarded as approximate versions of an improved impulse approximation, and the consequences of this are explored. 80 references. (A.G.W.)

21588 POSITRON COLLISIONS. Bransden, B. H. (Univ. of Durham, Eng.). pp 169-248 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

A general review of the processes involved in interactions of positrons with gases is followed by a more detailed treatment of elastic scattering of positrons by atoms. Approximation methods are described, and the variational method and the method of polarized orbitals are applied to scattering by hydrogen and the rare gases. The formation and scattering of positronium in hydrogen and helium are discussed. 96 references. (A.G.W.)

21589 EXPERIMENTS WITH COLLIDING CHARGED-PARTICLE BEAMS. Dolder, K. T. (Univ. of Newcastle upon Tyne, Eng.). pp 249-334 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

A review of general principles of experiments with colliding charged-particle beams is followed by discussion of five types of experiments already performed: electron-impact ionization of positive ions, electron detachment from negative ions by electron impact, excitation of positive ions by electron impact, production of protons by collisions between electrons and H_2^+ ions, and collisions between ions. Some experimental techniques are described, and some alternative methods used to study collisions between electrons and ions are considered. 165 references. (A.G.W.)

21590 BINARY-ENCOUNTER AND CLASSICAL COLLISION THEORIES. Vriens, L. (FOM-Instituut voor Atoom-en Molecuulfysica, Amsterdam). pp 335-98 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

This review of the binary-encounter collision theory includes a historical survey, a detailed derivation of binary-encounter cross-section relations, and applications to ionization, excitation, and charge transfer in electron–atom and ion–atom collisions. The range of validity of the theory is studied by comparing with experiment, first Born approximation, and three-body classical theory. 112 references. (A.G.W.)

21591 COINCIDENCE MEASUREMENTS. Kessel, Quentin C. (High Voltage Engineering Corp., Burlington, Mass.). pp 399-462 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

The theory of coincidence measurements in atomic scattering experiments and the apparatus used are reviewed. Coincidence scattering data taken since 1963 are summarized, with emphasis on pointing out those features that are common to all ion–atom combinations studied and isolating those features that seem to be characteristic of a particular combination. The development of ideas concerning mechanisms of ionization in heavy-ion collisions is discussed. Possibilities for future coincidence measurements are considered briefly. 50 references. (A.G.W.)

21592 HIGH-RESOLUTION ELECTRON BEAMS AND THEIR APPLICATION. Kerwin, L.; Marmet, P.; Carette, J. D. (Univ. Laval, Quebec). pp 525-81 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

Instruments currently used for high-resolution electron-beam investigations and their combination into what is called an electron spectroscope are described. Data from electron-beam studies of elastic and inelastic scattering and ionization are summarized. 168 references. (A.G.W.)

21593 CLASSICAL SCATTERING THEORY: ELASTIC COLLISIONS. Miles, J. R. N.; Dahler, J. S. (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 52: 616-21(15 Jan 1970).

The methods of Prigogine and Resibois are used to construct a description of classical two-body scattering events, which bears a close formal analogy to that of time-dependent quantum scattering theory. It is shown how the distribution in phase space evolves after long times into a steady-state scattering form, from which expressions for cross sections and transition rates are obtained by means similar to those of the quantum-mechanical treatment. These expressions are shown to be equivalent to the conventional classical formulas but offer in principle alternative means of evaluation. (auth)

21594 COMPLETE PARTIAL-WAVE TREATMENT OF COMPOUND-STATE (ROTATIONAL EXCITATION) RESONANCES IN

SUBTHRESHOLD SCATTERING OF AN ATOM BY A DIATOMIC MOLECULE. Muckerman, J. T.; Bernstein, R. B. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 52: 606-16(15 Jan 1970).

The present study deals with quantitative prediction of compound-state resonance energies and widths in the elastic scattering of a diatomic molecule at energies below the threshold for rotational excitation. Previous work had been restricted to the weak interchannel coupling limit or to s-wave scattering only (but with no restriction on coupling strength). The two-state adiabatic decoupling approximation, adequate to describe the s-wave resonance phenomenon, requires modification to be practical for higher partial waves. This extension is carried out and calculations yield good agreement with exact (close-coupled) results. It is then used in the numerical solution of the complete threshold resonance problem for an example involving moderately strong coupling, for which other approximate methods are inadequate. This decoupling approximation, which yields accurate energies and semiquantitative lifetimes of the compound states, leads also to a spectroscopic correlation scheme, i.e., an indexing of the spectrum of resonances. (auth)

21595 STUDY OF THE STATISTICAL MODEL FOR MOLECULAR COLLISIONS. Miller, William H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 52: 543-51(15 Jan 1970).

Formation of a collision complex is considered in terms of Feshbach's formulation of resonant scattering, and a generalized statistical approximation is obtained. It is seen how the usual statistical model follows as a special case; possible extensions are also discussed. A detailed application of the statistical model to rotationally inelastic collisions is presented, and general features of the total and differential cross sections are discussed. A simplified treatment of a chemical reaction that proceeds via complex formation is also presented. (auth)

21596 SPECIFIC EXCITATION OF $N_2(C\ ^3\pi_u)$ AND SPECIFIC IONIZATION BY 4.3 MeV α PARTICLES. Tatischeff, I. (Institut de Physique Nucleaire, Paris). J. Chem. Phys.; 52: 503-8(15 Jan 1970).

In this paper, specific excitation, dN^*/dx (the number of excited molecules per millimeter) is compared with specific ionization, dN^+/dx (the number of ions created per millimeter) along the track of 4.3-MeV α particles in nitrogen at atmospheric pressure. The knowledge of the ratio of the collisional to the radiative rate constants allows one to calculate the specific excitation from measurements of specific luminescence. In this way, the specific excitation and specific ionization at atmospheric pressure were calculated from measurements of specific luminescence and ionization at eight pressures ranging from 23 to 253 torr. It is assumed that the comparison along the entire track concerns ionization and excitation leading to the state $C\ ^3\pi_u$. The excitation is found to be nearly proportional to the ionization along most of the α track. Beyond the average range of the α particles, however, excitation seems to become much more likely than ionization. This could be simply the result of a higher efficiency for excitation, compared with ionization, when the secondary electrons are formed with lower velocities. In addition, it may partly result from the appearance of another type of excitation of N_2 ($C\ ^3\pi_u$), namely excitation by He^+ ions. (auth)

21597 BORN CROSS SECTIONS AND RATE CONSTANTS FOR INELASTIC COLLISIONS OF ELECTRONS WITH EXCITED ATOMS. Podlubnyi, L. I.; Sergeev, V. M. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 216-18(Sep 1969).

Translated from Opt. Spektrosk.; 27: 404-7(Sep 1969).

The cross sections and rate constants for transitions between highly excited states of the hydrogen atom due to collisions with electrons were calculated in the first Born approximation. Simple asymptotic formulas were obtained, which can be used in practical calculations. (auth)

21598 ELECTRON CAPTURE BY MULTIPLY CHARGED IONS. Winter, G. J. M.; Bierman, D. J.; Van de Weg, W. F. (FOM-Instituut voor Atoom-en Molecuulfysica, Amsterdam). Phys. Lett.; 31A: 170-1(23 Feb 1970).

A method is described to determine simultaneously the cross sections for capture of electrons by ions of charge 1 to 8. The initial charge states are obtained by large-angle scattering of keV singly charged ions in the target gas. (auth)

21599 QUANTIZATION OF COULOMB WAVE VECTORS AND ITS APPLICATION TO IONIZATION OF ATOMS. Kang, I. -J.; Kerch, R. L. (Southern Illinois Univ., Edwardsville). Phys. Lett.; 31A: 172-3(23 Feb 1970).

A Coulomb wave vector is quantized by confining the wave in a paraboloidal box. The result is then applied to explain the observed threshold behavior of the ionization coefficient of helium atoms by electron impact. (auth)

21600 ABSOLUTE EXCITATION CROSS SECTION OF THE K^+ RESONANCE STATES IN COLLISIONS WITH ARGON ATOMS. Bobashev, S. V. (Ioffe Physical Tech. Inst., Leningrad). Phys. Lett.; 31A: 204-5(23 Feb 1970).

To measure absolute values of the intensity of spectral lines in the vacuum ultraviolet a photoionization chamber of a new design was constructed. The absolute values of the cross sections for the excitation of K II resonance lines were determined. (auth)

21601 COLLISIONS OF FAST Li, Na, AND K ATOMS AND IONS WITH ALKALI METAL AND NOBLE GAS ATOMS (20 TO 155 keV). Pivovar, L. I.; Nikolaichuk, L. I. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 97-103(Jan 1970). (In Russian).

The cross sections for electron loss and the equilibrium charge distribution in Li^+, Na^+, and K^+ ion beams traversing Na or K vapor or He, Ne, and Ar gases are measured. The cross sections for electron loss by fast Li, Na, and K atoms are determined on the basis of data on equilibrium charge distributions and the data from a previous paper. The cross sections for electron capture by doubly charged Li^{2+}, Na^{2+}, and K^{2+} ions are presented. The largest values of the ionization cross sections of fast atoms are observed in collisons between identical alkali metal atoms. (auth)

21602 SINGLE AND MULTIPLE IONIZATION OF LEAD ATOMS BY ELECTRONS. Pavlov, S. I.; Stotskii, G. I. Zh. Eksp. Teor. Fiz.; 58: 108-14(Jan 1970). (In Russian).

Methods for measurement of the true cross sections for ion production by electron impact are analyzed. For measurement of the true cross sections one must know the exact value of the proportionality coefficients between the ion current in the source and the ion current recorded by the detector or else apply the so-called difference method. The difference method is employed for measuring the cross sections for production of Pb^+ to Pb^{5+} ions by electron impact. The cross sections were normalized according to the known value of the total cross section. The single ionization cross section measured for lead at energies above 260 eV agrees with that calculated in the Born approximation. A structure can be discerned in the initial part of the single ionization curve. The results confirm the power threshold law for single and double ionization of lead atoms by electrons. (auth)

21603 ASYMPTOTIC BEHAVIOR OF THE CHARGE EXCHANGE CROSS SECTION. Brodskii, A. M.; Potapov, V. S.; Tolmachev, V. V. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 58: 264-80(Jan 1970). (In Russian).

The asymptotic behavior of terms of the iteration expansion of the transition amplitude for the reaction $H(1s) + H^+ \rightarrow H^+ + H(n,l)$ is studied for the extreme case of high relative velocities of the colliding particles. Asymptotic expressions are obtained for the total and differential cross sections. Some features that the Born approximation possesses when applied to rearrangement problems are noted. (auth)

21604 ABSOLUTE MEASUREMENTS OF THE EXCITATION FUNCTIONS FOR KII LINES PRODUCED IN COLLISIONS BETWEEN K^+ IONS AND He ATOMS. Pop, S. S.; Krivskii, I. Yu.; Zapesochnyi, I. P.; Baletskaya, M. V. (Uzhgorod State Univ., USSR). Zh. Eksp. Teor. Fiz.; 58: 810-16(Mar 1970). (In Russian).

The absolute course of the excitation functions for the K II spectral lines λ = 3897.9, 4134.7, 4149.2, 4186.2, 4222.9 + 4225.7, 4263, 4305 + 4309.1, 4388.2, 4608.5 + 4595.6, and 4829.2 Å and also for the He I line λ = 5875.6 Å were measured for ion energies between 0.5 and 34 keV. The excitation functions for the K II lines have two peaks. Qualitatively the course of the excitation functions is the same for all K II lines studied. The maximal values of the excitation cross sections of the K II lines investigated vary between 0.25×10^{-18} and 2.9×10^{-18} cm^2 whereas the maximal value of the total excitation cross section for all measured lines in the visible range of the spectrum is 1.4×10^{-17} cm^2. The theoretical curves calculated by the Landau–Zener formula satisfactorily agree with the experimental curves. (auth)

21605 NEGATIVE ION DECOMPOSITION IN THE SHORT RANGE POTENTIAL APPROXIMATION. Demkov, Yu. N.; Drukarev, G. F.; Kuchinskii, V. V. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 58: 944-51(Mar 1970). (In Russian).

The cross section for electron detachment in collisions between negative ions A^- and atoms A is considered by the short-range-potential method. The adiabatic approximation is employed for quasi-stationary states; nonzero probability for survival of the A_2^- systems is taken into account and correspondingly allowance is made for the energy dependence of the cross section. The energy distribution of the emitted electrons is calculated in the same approximation. The case of different atoms and ions (A^- + B) can be

reduced to the case ($A^- + A$) by renormalizing the parameters of the problem. The results are illustrated by the process $H^- + H \rightarrow H + H + e$ and are compared with experiments and with other calculations. (auth)

Atomic Theory

21606 VECTOR COUPLING COEFFICIENTS FOR COMPLEX ATOMS. Nussbaumer, H. (University Coll., London). Comput. Phys. Commun.; 1: 191-7(Jan 1970).

The program described calculates vector coupling coefficients and Slater determinants to represent the eigenfunctions of a complex atom in the one-configuration representation as a linear combination of Slater states. The L–S coupling scheme is used, and allowance is made for SL degeneracy. (J.F.P.)

21607 HARTREE–FOCK–SLATER SELF-CONSISTENT FIELD CALCULATIONS. Desclaux, J. P. (Commissariat a l'Energie Atomique, Villeneuve-St-Georges, France). Comput. Phys. Commun.; 1: 216-22(Jan 1970).

The computer program for the Hartree–Fock self-consistent field calculations makes use of the Slater approximation for replacing the exchange potential by a local potential. A better stability of the solution in the region of exponential decay of the wave functions is obtained. (C.E.S.)

21608 MULTI-CONFIGURATION HARTREE–FOCK PROGRAM. Froese Fischer, Charlotte (Univ. of Waterloo, Ont.). Comput. Phys. Commun.; 1: 151-66(Jan 1970).

The description of the multiconfigurational Hartree–Fock program covers the data requirements, method of solution, summary of subroutines, and program limitations. Also discussed are the accuracy of numerical results, machine-dependent parameters, data input for the atomic structure program, and sample data cards and results. This program determines numerical nonrelativistic Hartree–Fock results within the multiconfiguration approximation for atoms in a bound state. (J.F.P.)

21609 VARIATION–PERTURBATION EXPANSIONS AND PADE APPROXIMANTS TO THE ENERGY. Braendas, E.; Goscinski, O. (Univ. of Florida, Gainesville. Uppsala Univ. Phys. Rev., A; 1: 552-60(Mar 1970).

The variational solutions to the Rayleigh–Schrödinger inhomogeneous equations are derived by simple matrix algebra. It is shown how the approximate perturbation energies and wave functions obtained in this way obey the same type of equations as the exact ones. This permits the formulation of a variation–iteration theory convenient for numerical applications. Results for the He-like ions show that the conventional linear series is less suitable than the present method in obtaining accurate energies. The use of inner projection techniques leads to an efficient calculation of Padé approximants to the energy series, which show remarkable convergence properties. (auth)

21610 NATURE OF THE CONFIGURATION-INTERACTION METHOD IN AB INITIO CALCULATIONS. I. Ne GROUND STATE. Barr, Tery L.; Davidson, Ernest R. (Univ. of Washington, Seattle). Phys. Rev., A; 1: 644-58(Mar 1970).

A detailed study of the correlation energy of Ne was made in order to analyze the nature of the configuration-interaction (CI) method in ab initio calculations. Both the Bethe-Goldstone method of Nesbet and the total-pair-excitation-block method (TPEB) were examined. A series of calculations was made using both "atom-centered" and "shell-centered" basis sets. The most detailed calculations gave −0.333 a.u. (88%) for the correlation energy by the TPEB method, and −0.396 a.u. (104%) by the sum-of-the-pairs technique. The difference between these two values is mainly the so-called pair–pair interactions, which have been considered too small to be important to other investigators. A series of perturbation calculations on the triple and quadruple excitations gives ~1.5% of the total correlation energy. A complete CI calculation with a very limited basis set was done on the p block of Ne. The results of this calculation are in agreement with our total-atom calculation, except that now the TPEB calculation gave about 98.5%, and the sum of the pairs about 115% of the complete CI result. The effect on the pair correlation energy of a unitary transformation of the outer-shell occupied self-consistent-field orbitals was also studied. Only a small difference in the results was obtained. (auth)

21611 MANY-BODY CONTRIBUTIONS TO ATOMIC CORRELATION ENERGIES. Micha, David A. (Univ. of California, San Diego, La Jolla). Phys. Rev., A; 1: 755-64(Mar 1970).

Many-electron perturbation theory was used to investigate the contribution to atomic correlation energies from high-order terms. The treatment analyzes several aspects of the inhomogeneous-electron-gas and the electron-pair approaches. It discusses in detail the coupling of electronic angular moments with the multipolar components of the Coulomb interaction. The results are expressed in terms of renormalized propagators, which include partial perturbation summations to infinite order. Calculations were carried out for the neon atom to ascertain the importance of contributions from many-body ring diagrams. Numerical results indicate that the ratio of many-body to two-body correlation energies is about 0.10 for the 2p subshell of Ne I and that the many-body correlation energy has a positive sign. (auth)

21612 SEMISTATISTICAL MODEL FOR ELECTRONS IN ATOMS. Ashby, N.; Holzman, M. A. (Univ. of Colorado, Boulder). Phys. Rev., A; 1: 764-77(Mar 1970).

A simple modification of the Thomas–Fermi statistical model for electrons in atoms and ions is presented, which corrects one of the model's major deficiencies, namely, its overestimation of the electron density near the nucleus. Exploiting the fact that near the nucleus the potential is nearly Coulombic, boundary conditions are derived from wave mechanics and incorporated into the model equations. The resulting equations are expressed in integral form and solved by a straightforward iterative technique. Results for total atomic energies show marked improvement over the corresponding results obtained from the Thomas–Fermi model, with only a slight increase in the required computational effort. The procedure is extended to obtain a relativistic statistical model of the atom. Numerical results show good agreement with wave mechanics in total energy calculations and in the form of the density near the nucleus. The relativistic effects are of greater magnitude than exchange or inhomogeneity corrections to the Thomas–Fermi model for large-Z atoms. (auth)

21613 ON THE Z INDEPENDENCE OF CORRELATION ENERGY IN HELIUM-LIKE IONS. Das, G. (Argonne National Lab., Ill.). J. Chem. Phys.; 52: 1004-5(15 Jan 1970).

The correlation energy defined as the difference between the experimental and Hartree–Fock energies is roughly independent of the nuclear charge in helium-like ions. An analytical proof is suggested that, when properly interpreted, this statement holds for other systems, too. (A.G.W.)

21614 PROJECTED HARTREE PRODUCT WAVE FUNCTIONS. V. DENSITY MATRICES AND OPERATORS CONTAINING SPIN. Gallup, G. A. (Univ. of Nebraska, Lincoln). J. Chem. Phys.; 52: 893-900(15 Jan 1970).

Formulas are given to allow the calculation of the various spin components of the first-order density and transition-density matrices from one spatial component of a pure spin-state wave function and certain reduced operators. Similar expressions are given for the second-order density for singlet and doublet systems. These results are useful for the calculation of matrix elements of operators containing the spin. (auth)

21615 PROJECTED HARTREE PRODUCT WAVE FUNCTION. IV. RADIAL CORRELATION IN SOME THREE- AND FOUR-ELECTRON ATOMS. Heikes, L. G.; Gallup, G. A. (Univ. of Nebraska, Lincoln). J. Chem. Phys.; 52: 888-92(15 Jan 1970).

The energies of some three- and four-electron atoms including radial correlation were determined by a spin-free version of the projected Hartree–Fock method. The wave function possesses the maximum flexibility allowable under the general restrictions of the method, and it is shown that this flexibility is necessary to adequately account for the differences between intra- and intershell correlation. Some comments on the AMO method are included. (auth)

21616 FEENBERG–GOLDHAMMER PROCEDURE AND GEOMETRIC APPROXIMATION IN HARTREE–FOCK PERTURBATION THEORY. Amos, A. T. (Univ. of Waterloo, Ont.). J. Chem. Phys.; 52: 603-5(15 Jan 1970).

The uncoupled Hartree–Fock procedure plus the geometric approximation is the most economical one for computing second-order perturbation energies of atoms and molecules. The geometric approximation, however, has generally been considered empirical in nature. Here it is shown that, in fact, it is related to the Feenberg–Goldhammer procedure for improving the convergence of perturbation series. (auth)

Cosmic Radiation

Refer also to abstracts 21910, 21913–21916, 21931, 21932, 21940, and 21969.

21617 REMARKS ON THE MODULATION OF LOW-RIGIDITY PARTICLES IN COSMIC RADIATION. Sandor, T. (Louisiana State Univ., Baton Rouge). Can. J. Phys.; 48: 744-6(15 Mar 1970).

The flux of low-energy positrons of radioactive origin in cosmic radiation has been estimated from collisions of the B, C, N, O, Na, Mg, Ti, Cr, Fe, Ni, Co, and Cu nuclei with protons of interstellar matter. The estimations are not compatible with a residual solar modulation of the form $\exp(-\eta/R\beta)$ (where η, R, and β are the modulation parameter, rigidity, and velocity, respectively) for the values of R smaller than ~0.3 BV. (auth) (Canada)

21618 ASYMMETRIC EFFECTS IN SECULAR COSMIC-RAY VARIATIONS. Chirkov, N. P. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 595-6(1969).

Translated from Geomagn. Aeron.; 9: 738-9(1969).

Anomalous effects in some cosmic-ray variations observed at high latitudes have been previously noted. The amplitudes of many isotropic variations at geomagnetic latitudes $\Phi > 50°$ continue to increase with latitude, although these variations must be of the same amplitude because the energy characteristics of detectors are the same at $\Phi > 50°$. This difference has been explained by the addition of an isotropic flux along the z axis to which high-latitude stations are most sensitive. The effect is examined on the basis of data on secular variations recorded by neutron supermonitors at Deep River, Goose Bay, Inyuvik, and Alert. (W.D.M.)

21619 BAROMETRIC EFFECT OF THE NEUTRON COMPONENT OF COSMIC RAYS IN THE PRESENCE OF A BACKGROUND. Kaminer, N. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 597-8(1969).

Translated from Geomagn. Aeron.; 9: 740-1(1969).

With the relatively low statistical accuracy of cosmic-ray records made with standard neutron monitors of the IGY–IQSY period, the presence of a background and the failure to allow for it could have no noticeable effect on the results of cosmic-ray variation measurements. But modern neutron supermonitors have an effective recording area of ~20 m^2 and a mean hourly statistical accuracy of ~0.1%. This requires correct allowance for all factors that may distort the recorded cosmic-ray variations. Therefore, it was felt to be of interest to estimate the errors in variation measurements that could result from a failure to allow for the neutron monitor background. (W.D.M.)

21620 DISTORTION OF AN EXTERNAL, ANISOTROPIC GALACTIC COSMIC-RAY FLUX IN THE SOLAR SYSTEM. Belov, A. V.; Dorman, L. I. (Moscow State Univ. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 496-9(1969).

Translated from Geomagn. Aeron.; 9: 613-16(1969).

The expected distortion of an external, anisotropic galactic cosmic-ray flux in interplanetary space is found, proceeding from the equation of isotropic diffusion, as a function of the transport mean free path for scattering and the degree of anisotropy. (auth)

21621 COSMIC-RAY ACCELERATION BY CORPUSCULAR STREAMS AND SOLAR-WIND CHARACTERISTICS. Dorman, L. I.; Kaminer, N. S.; Kobuladze, T. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 500-5(1969).

Translated from Geomagn. Aeron.; 9: 617-24(1969).

The relationship between increases in cosmic-ray intensity before Forbush decreases and the characteristics of the plasma and of the magnetic field of the interplanetary medium is examined. It is shown that the amplitude of the increase depends on the velocity of the corpuscular stream, on the velocity of the undisturbed solar wind defined in terms of the K_p index, and on the solar longitude of a chromospheric flare. Quantitative estimates are given of the relationship between these factors and the amplitude of the intensity increase. (auth)

21622 SHORT-PERIOD FLUCTUATIONS OF COSMIC RAY INTENSITY AT THE GEOMAGNETIC EQUATOR AND THEIR SOLAR AND TERRESTRIAL RELATIONSHIP. Dhanju, M. S.; Sarabhai, V. (Physical Research Lab., Ahmedabad, India). J. Geophys. Res.; 75: 1795-1801(1 Apr 1970).

By using power spectrum analysis on the μ meson intensity records of a high counting rate instrument (10^6 counts/min) operated at Chacaltaya, Bolivia, it was possible to identify the presence of cosmic-ray fluctuations of 15 to 19 and 25 to 28 cycles per hour (cph). These frequencies were found at a 99% level of significance in the average of 1034 three-hour samples extending from November 1965 to June 1966. Comparison with Pioneer 6 measurements (Ness et al., 1966) indicates that the magnetosheath field, at a distance of about 10 R_E, and the interplanetary magnetic field show peaks in spectral density that correspond closely (though not identically) with peaks in muon intensity. It is most plausible that these cosmic-ray fluctuations are caused by the fluctuations of geomagnetic field corresponding to an amplitude of about 20 γ in the dipole magnetic field. Magnetic field measurements conducted in the magnetosphere by Explorer 6 (Judge and Coleman, 1962) and Explorer 12 (Patel and Cahill, 1964) show similar oscillations. Recent observations by ATS 1 confirm the presence of magnetic oscillations of similar frequencies at about 6 R_E. These frequencies are also found in the geomagnetic micropulsations observed at the surface of the earth. The integrated power of cosmic-ray oscillations in the frequency range of 6 to 30 cph has been studied at various periods, and its solar–terrestrial relationship is examined. The association of observed frequencies in cosmic rays with frequencies in the solar photosphere and the interplanetary magnetic field, as well as the resonance frequencies of the magnetosphere, are discussed. (auth)

21623 A COMPARISON OF THE COSMIC-RAY DAILY VARIATION RECORDED BY NEUTRON MONITORS AT DIFFERENT ELEVATIONS. Jenkins, Robert W.; Lockwood, John A. (Univ. of New Hampshire, Durham). J. Geophys. Res.; 75: 1802-10(1 Apr 1970).

The amplitudes of the first harmonic of the diurnal variation in the pressure-corrected cosmic-ray neutron monitor rate have been examined for several stations at different altitudes but at the same cutoff rigidity (~1.3 GV). An increase in the amplitude of the mean diurnal variation from sea level to 800 g/cm^2 is observed, which is $19.4 \pm 4.2\%$ for 1964 to 1965, and $7.8 \pm 3.3\%$ for 1967 to 1968. Several effects are required to explain this variation with altitude and its observed time dependence, the most significant of which is the diurnal change in geomagnetic cutoff rigidity. (auth)

21624 RADIO PULSES AND THE DETECTION OF LARGE AIR SHOWERS. Kazen, W. E.; Hendel, A. Z.; Smith, Howard; Shah, N. J. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 24: 476-9(2 Mar 1970).

Radio pulses can be used to measure the arrival directions of large cosmic-ray air showers. Since nearly all very large showers and nearly all large zenith-angle showers had detectable radio pulses, the method shows promise for the detection of such showers. (auth)

21625 RADIAL DISTRIBUTION OF THE FREQUENCY OF EXTENSIVE AIR SHOWERS. Jatczak, Jerzy (Univ. of Lodz, Poland). Nukleonika; 14: 733-41(Aug 1969).

The function of the radial distribution of the counting rate for extensive air showers is presented. The function is averaged with respect to the range of the exponent γ and the age parameter s. Calculations are performed and the results are presented in graphic form. (auth)

Direct Energy Conversion

Refer also to abstract 21646.

21626 SECOND SEMINAR ON APPLIED MAGNETOHYDRODYNAMICS AND HIGH TEMPERATURE GASDYNAMICS, PRAGUE, MAY 1968. Pr. Inst. Masz. Przeply.; No. 46, 1-250(1969). (In several languages). (CONF-680558).

Separate abstracts were prepared for ten articles. (M.O.W.)

For abstracts of individual papers see: 21575, 21627, 21644–21646, 21764, 21765, 21783, 21811, and 21826.

21627 STUDY OF INDUCTION MHD GENERATORS WITH RADIAL COMPONENT OF THE MAGNETIC FIELD. Kracik, Jiri; Lego, Jindrich; Knize, Stanislav (Ceske Vysoke Uceni Technicke, Prague). Pr. Inst. Masz. Przeply.; No. 46, 133-8 (1969).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

The induction MHD generator with special geometric configuration was studied from the point of view of its properties and operation. Theoretical analyses were made both for continuous and pulse mass flow. The latter case was also studied experimentally. The configuration of the generator is as follows: the flux density has a radial component, the working fluid velocity has an axial component, and the electric field intensity and current density has an azimuthal component only. The working space of the generator is enclosed between two coaxial cylinders. The cylindrical coordinate system is used. Differential equations for studying the generator operation were derived from the usual equations for MHD generators. (M.H.R.)

21628 INFLUENCE OF METHODS FOR DEVELOPING HIGH-TEMPERATURES ON EFFECTIVE OPERATION OF OPEN-CYCLE MHD INSTALLATIONS. Shumyatskii, B. Ya.; Sokol'skii,

A. G.; Pereletov, I. I.; Khokhlov, L. K.; Rogachev, A. P.; Koptev, V. M. (Inst. of High-Temperatures, Moscow). Teplofiz. Vys. Temp.; 7: 754-65(Jul-Aug 1969). (In Russian).

Various methods were studied for obtaining high-temperatures (high-temperature air heating, oxygen enrichment of air, and preliminary thermochemical processing of fuel—conversion by cracking) for efficient combination of MHD electric power plants. The influence of these methods on the basic parameters of the power plants and geometric characteristics of MHD generators was analyzed and comparisons were made of thermal efficiencies. (tr-auth)

21629 STUDY OF SEGMENTED-ELECTRODE BOUNDARY LAYERS IN MHD GENERATORS. Shelton, Samuel Viron. Atlanta; Georgia Inst. of Tech. (1969). 191p.

Thesis.

The details and characteristics of electrode boundary layers in constant velocity, segmented-electrode MHD generators, using potassium seeded argon as the working fluid, are calculated in this study. A nonequilibrium electrical conductivity model, which has been experimentally verified in electric fields at appropriate current densities, is taken in the free stream flow as well as the boundary layers. Hall currents are included and the two-dimensional boundary-layer equations are solved by finite difference methods with no similarity assumption. Heat transfer, drag, and electrical losses are evaluated. (Diss. Abstr.)

21630 THE OPTIMIZATION OF MHD CONVERTORS WITH INCLINDED ELECTRODES AND OBLIQUE CONNECTIONS. Bobbio, Scipione; Greco, Oreste (Facolta di Ingegneria di Napoli, Naples). Elettrotecnica; 56: 379-91(Jul 1969). (In Italian).

The problem of optimization of a segmented-electrode oblique-connection MHD converter, envisioned in terms of an open-cycle plant, is studied with respect to the ratio between converted power and the volume of the chamber. First a variational-type optimization is derived depending on the principle of the maximum of Pontryagin and assuming that the control variable is a quantity proportional to the square of the Mach number. Second, on the assumption that the charge factor is a constant along the length of the unit, an optimization of the parametric type is effected for evaluation of assigned values of parameters which figure in the mathematical model. The results are reported in diagrams which show the variation along the length of the units of greatest significance, and the variation of indexes by variation of different parameters. At optimum flux, the total enthalpy of the gas decreases nearly linearly along the length of the unit, the charge factor remains nearly constant, and the Mach number varies nearly linearly in one part of the chamber and is nearly constant in the remainder. (BBB)

21631 MHD, MEANS FOR MASSIVE PRODUCTION OF ELECTRIC ENERGY. Masse, Jean (Direction des Etudes et Recherches, EDF, Paris). Sciences (Paris); 10: 56-63(Jan-Apr 1969). (In French).

Application of MHD generators for the large-scale production of power is considered. The principal types of generators are analyzed: segmented electrodes, right-angle construction, inclined construction, and disc generators. Closed- and open-cycle MHD plants are compared; more frequently present studies are devoted to applications of the latter. Design of nozzles is considered as an important feature in distinguishing different cycles, in which the Hall effect and ionization near equilibrium play an important role. Problems in technology are reviewed. Design of the small 2-MW unit at Renardieres, France, constructed by E.D.F. is examined; the Mark V generator of the Avco Corporation, the pilot unit at Marchwood, England, Japanese units, and the Russian plants (U 2, 20 MW; ENIN 2, 200 MW; U 25, 250) are noted. Technical and economic planning suggests that the Soviet Union may be the country best suited for applications of MHD generators. (BBB)

21632 WALL STRUCTURES FOR MHD CONVERSION DUCTS. Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,184,383. 18 Mar 1970. Priority date 16 Dec 1966, France.

A wall structure for an MHD conversion duct is described. It comprises a casing of thermally conductive metal having cooling passages and metallic partitioning disposed on one face of the casing with extensions which penetrate the passages. The partitioning is anchored in the casing and widens toward the front face of the wall. Bricks of electrically insulating, dense, ceramic material are set in the partitioning and possess dimensions of the same order in both directions at the front face of the wall. A slab of dense, electrically insulating ceramic material is interposed between the casing and the bricks through which the extensions of the partitioning pass. Sleeves of insulating ceramic material surround the extensions where these pass through the casing to reach the cooling passages. (M.H.R.)

21633 MAGNETOHYDRODYNAMIC OUTFLOW THROUGH A SQUARE CHANNEL IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD: IN CASES WHERE CONDUCTING SIDES ARE PARALLEL TO APPLIED MAGNETIC FIELD. Jaumotte, Andre L.; Hirsch, Charles; Strul, Salomon (Univ., Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 55: 643-55(1969). (In French).

Head variation measurements are reported in an MHD flow of mercury through a square channel with conducting sides parallel to the applied magnetic field and connected by an external circuit which is able to provide a direct current of both signs flowing through the section. (auth)

21634 CALCULATION OF FLOW IN A NOZZLE AND A DIFFUSOR WITH MHD INTERACTION. Stepchkov, A. A. Izv. Vyssh. Ucheb. Zaved., Aviats. Tekh.; 11: 158-62(1968). (In Russian).

The operation of an MHD generator channel as a wind tunnel is studied. The parameter of the nozzle cross section and the diffusor throat are found on the basis of the continuity equation. Flows at Mach numbers from 1 to 4 are considered. An equation is derived for the determination of the minimum size of the diffusor throat and an expression describing the pressure change is given. (IAA)

21635 EQUIVALENT CIRCUITS OF THE FARADAY-TYPE MHD GENERATOR WITH NONUNIFORM GAS PROPERTIES IN THE ELECTRIC FIELD DIRECTION. Celinski, Z. (Inst. of Nuclear Research, Warsaw). Arch. Elketrotech. (Warsaw); 18: 747-66(1969).

The effects of gas velocity and temperature distributions in the direction of an induced electric field on the electrical parameters of the Faraday-type MHD generator are considered. When gas properties are varying in the y direction, strong Hall currents are flowing in the x direction. These currents deteriorate the electrical performance of the generator; the A parameter which characterizes this deterioration is determined. The decrease of electrical terminal values may be strong especially in the case when the magnetic induction is high. The parameter A is proportional to B^2 and depends on the distribution functions of the gas conductivity and of the Hall parameter. The distributions of the electrical parameters in the y direction (current density, electrical potential, electrical field) become more nonuniform with the increasing of B. In this work, a constant channel cross section, no-leakage currents in the walls, a constant magnetic field, and constant electric and gasdynamic parameters along the channel are assumed. It is also assumed that the distributions of the gas parameters are independent of the load factor. A numerical example is calculated. (auth)

21636 EQUIVALENT CIRCUITS OF THE FARADAY-TYPE MHD GENERATOR WITH NONUNIFORM GAS PROPERTIES IN THE MAGNETIC FIELD DIRECTION. Celinski, Z. (Inst. of Nuclear Research, Warsaw). Arch. Elektrotech. ((Warsaw); 18: 767-87(1969).

The effects of gas velocity and temperature distributions in the direction of a magnetic field, on the electrical parameters of the Faraday-type MHD generator are considered. As gas properties are varying along the z axis, circulating currents are flowing in the cross-sectional area of the channel due to the nonuniform distribution of the gas velocity. These currents induce the Hall circulating currents along the x axis. The Ohmic losses due to the circulating currents are independent of the load factor. They are not high, e.g., they are less than 3% of the generated power for the typical distributions. The maximum point of the efficiency curve vs. load factor is shifted to the lower values of the generator loading. The terminal voltage and generated power increase slightly; the internal resistance does not change in sufficient manner in comparison to the constant-gas-property generator. The weak Hall fields can be induced at the open-circuit conditions of the generator due to the nonuniform distribution of the Hall parameter. In this work a constant channel cross section, no-leakage currents in the walls, a constant magnetic field, and constant electric and gasdynamic parameters along the channel are assumed. It is also assumed that the distributions of the gas parameters are independent of the load factor. A numerical example is calculated. (auth)

21637 SHEATH STRUCTURE IN A PLASMA DIODE. Sockol, Peter M. (Lewis Research Center, Cleveland). Phys. Fluids; 13: 1060-5(Apr 1970).

The plasma diode is proposed as a vehicle for testing theories on sheath structure with collisions. A kinetic theory model of the plasma-sheath transition is used to analyze the operation of the diode. In particular, the sheath structure at the cold collector is obtained in the limiting cases where the local Debye length is much larger than and much smaller than the mean free path. Comparison of the theoretical current–voltage characteristics with

experimental ones obtained in a cesium thermionic converter shows that the slopes of the theoretical limiting curves bracket the experimental behavior quite closely. The theory is used to obtain values for the electron and ion diffusion coefficients and the collector work function. (auth)

21638 ISOTROPIC THERMOELECTRIC GENERATOR. Kodyukov, V. M.; Rogozinskii, A. I.; Fradkin, G. M.; Voronin, A. N.; Shinderov, B. L.; Kudasov, A. S. (to All-Union Scientific Research Inst. for Radiation Tech.). Russian Patent 194,901. (In Russian).

The isotopic thermoelectric generator described incorporates a thermal unit with a radioactive isotope, a thermoelectric battery, and a housing. To improve the stability of the converter's output parameters by regulating the emission of heat from the surface of the thermal unit to conform with the rate of variation in the heat liberation of the radioactive isotope, the generator housing is separated from the surface of the thermal unit by free thermal insulation connected to a drive mechanism. A number of thin-walled-cowl-like screens serve as the insulation. The thermal insulation drive mechanism represents a flexible coupling and a profiled shaft with a reducing gear actuated by a time mechanism. (JPRS)

21639 DETERMINATION OF THE THERMOELECTRIC FIGURE OF MERIT FROM THERMAL CONDUCTIVITY MEASUREMENTS. Al-Obaidi, T. A. A.; Goldsmid, H. J. (Bath Univ. of Tech., Eng.). Energy Convers.; 9: 131-2(Dec 1969).

The effect of a flow of electric current on the thermal conductivity of a thermoelectric material is considered, and it is shown how the effect can be used in determining the figure of merit for single thermoelements and thermocouples, and for whole modules. Some results are given for a p-type Bi_2Te_3 alloy. (UK)

21640 EXPERIMENTAL FIGURE OF MERIT FOR A THERMOELECTRIC GENERATOR. Berry, W. B. (Univ. of Notre Dame, Ind.). Energy Convers.; 9: 133-4(Dec 1969).

The experimental determination of the figure of merit for a thermoelectric generator couple is discussed. The basic experimental condition is that the temperature difference is maintained. The input energy rate required to maintain the temperature difference under open-circuit and short-circuit conditions yields the figure of merit and the efficiency. A measure of input heat rate gives information regarding the accuracy of the result. (UK)

21641 A 200-kW OPEN-CYCLE MHD RIG FOR TESTING ELECTRODES AND INSULATING WALLS. Yerouchalmi, D.; Carbonnelle, J. (CEN, Saclay, France). Energy Convers.; 9: 155-6(Dec 1969).

The test rig described was built primarily to test an MHD open-cycle laboratory channel with hot walls at controlled temperatures. A special burner was designed for use with fossil fuel gases at about 2500°C and giving a total thermal input of 200 kW. Refractory-lined elements were connected to the channel exit in order to study corrosion from the exhaust gases and also seed recovery. The ceramics used were mainly spinels for the electrodes and zirconites for the walls. Data are given on the working conditions, together with results obtained during several tests. (UK)

21642 LIMITING CHARACTERISTICS OF MHD GENERATOR WITH NONEQUILIBRIUM PLASMA. Gubarev, A. V.; Gurashvili, V. A. Izv. Akad. Nauk SSSR, Energ. Transp.; No. 1, 167-70(Jan-Feb 1970). (In Russian).

Maximum efficiency parameters for MHD generators operating with nonequilibrium plasma were found, using the equations of the energy balance for electrons and the turbulent plasma conductance as a function of the Hall parameter. It is shown that, for argon with additions of cesium vapors and electric load coefficient 0.8, the maximum pressure in a reactor should not exceed 100 atm even with maximum temperature of the gas in a reactor of ~2500°K, induction magnetic field of ~10 tesla, and power of one MHD generator channel of 3×10^6 kW. With reduced Mach number from 2.0 to 0.5, the maximum permissible pressure in the reactor is reduced from 70 to ~20 atm. (tr-auth)

21643 A CRITERION FOR ELECTRODE EROSION OR ENTRAINMENT IN MPD ARCS. Hassan, H. A. (North Carolina State Univ., Raleigh). Energy Convers.; 9: 157-8(Dec 1969).

It was shown that, for a given pressure near an electrode, there is a maximum current density above which erosion of the electrode material and/or entrainment of the background gas into the arc region will occur. (UK)

Fluid Physics

Refer also to abstracts 21575, 21633, and 21757.

21644 ELECTRICAL DISCHARGES IN GASES AS OBJECTS OF MAGNETOHYDRODYNAMICS INVESTIGATIONS. Rothhardt, Ludwig; Popov, Goze (Institut fuer Magnetohydrodynamik, Jena, Ger.). Pr. Inst. Masz. Przeply.; No. 46, 47-59(1969). (In German).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

Experiments with electric discharges in low-pressure argon, in presence of external magnetic fields, are described. The experiments were undertaken in order to study the magnetic reduction of transport coefficients and the drift evoked by magnetohydrodynamic forces. Both phenomena were distinctly observable in the following three experimental devices: a positive column of cylindrical symmetry, locally disturbed by a transverse magnetic field; a spherical discharge with concentric central cathode, exposed to approximately uniform magnetic field; and glow discharge of cylindrical symmetry in a uniform, axial magnetic field. All the phenomena observed in the first two devices could be explained in accord with the theories generally accepted in magnetohydrodynamics. The results obtained during the examination of the third device may change the present ideas concerning magnetized discharges. (auth)

21645 VELOCITY AND CURRENT DENSITY DISTRIBUTIONS IN AN ANNULAR MHD FLOW WITH HALL EFFECT. Rosenbaum, Walentina; Rothhardt, Ludwig (Institut fuer Magnetohydrodynamik, Jena, Ger.). Pr. Inst. Masz. Przeply.; No. 46, 103-9(1969). (In German).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

Magnetohydrodynamic behavior of a plasma flowing in an annular duct with a radial magnetic field is theoretically examined from the viewpoint of the distributions of velocity and current density. A closed solution for v_z, v_θ, j_z, j_θ and E_z in a general, two-dimensional problem is arrived at, for arbitrary values of the Hall parameter $\omega\tau$. (auth)

21646 ELECTROGASDYNAMIC FLOWS IN DUCTS. A LINEAR VOLTAGE GENERATOR. Brunne, Marek; Malaczynski, Gerard (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 46, 121-31(1969). (In German).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

The problems of EGD flows in axisymmetric ducts are discussed from the viewpoint of their application as electrogasdynamic voltage generators. General equations used for description of such flows are given and discussed. The Poiseuille and radial flows in a duct of variable cross-sectional area are considered, on the basis of the two-fluid model. The conditions that must be satisfied when a stationary flow model is assumed are discussed, as well as the solutions for the flow in the duct of a linear generator. As a result, the formulation of efficiency of the EGD process is proposed, and the distributions of ion density and field in the generator duct are defined, together with a subsidiary scheme of a linear generator. (auth)

21647 PROPAGATION OF INFINITESIMAL PERTURBATIONS IN ELECTROGASDYNAMIC POISEUILLE FLOW OF NONHOMOGENEOUS FLUID. Brunne, M. Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 17: 575-81(1969).

The propagation of small perturbations in a fluid flow between parallel planes was examined, assuming the fluid to be unipolar and weakly ionized. Solutions were given determining the electric field and ion density distribution for one-dimensional steady flow of nonhomogeneous fluid. The equation of ion waves dispersion in this flow was derived and discussed by the perturbation method. The limiting assumptions are here the same as in an earlier analysis. The present paper is a continuation of previous studies which, however, did not refer to nonhomogeneous media. Standard notation, and the SI system of units are used throughout. (BBB)

21648 ANALYTIC DESIGN OF REGULATORS FOR MAGNETOHYDRODYNAMIC PROCESSES. II. Sirazetdinov, T. K. Automat. Remote Contr. (USSR) (Engl. Transl.); No. 12, 1813-22(Dec 1967).

A general method is applied to the synthesis of the optimum control of the boundary layer of an electrically conductive, incompressible fluid on a flat plate. Flow in the boundary layer is considered. The fluid flow in an isolated region is isolated by means of a magnetic field such that the integral square deviations of the variables attain their least values. It is assumed that it is possible to generate a magnetic field arbitrarily distributed over the region. The problem is solved in an analogous manner if the magnetic field is

distributed over the region τ uniformly or according to a given law. An assumption that the nonstationary motion deviates little from the stationary solution is used. On the assumption that the control U depends only on time and the space coordinate, an expression is derived for the optimum control. Control is in fact accomplished by means of a magnetic field directed perpendicularly to the plate. (BBB)

21649 INTERRELATION OF STATIC, MAGNETIC, AND DYNAMIC TURBULENT PRESSURES OF A CONDUCTING FLUID IN A MAGNETIC FIELD. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Phys. Rev., A; 1: 464-6(Feb 1970).

The relation between the mean-square fluctuations of magnetostatic and dynamic pressures is derived for a turbulent fluid of ideal conductivity in an exterior magnetic field. (auth)

21650 STEADY MAGNETOHYDRODYNAMIC FLOW IN AN INSULATING CIRCULAR PIPE. Waechter, R. T. (University Coll., London). Mathematika; 16: 249-62(1969).

The steady pressure-driven flow of conducting fluid through an insulating circular pipe in the presence of a transverse applied magnetic field is investigated. A Watson transformation (or the Poisson summation formula) is used to achieve a direct analysis of the relevant exact expressions for the circular pipe. The formal solution, the asymptotic analysis of the flow field at large Hartmann number, and the asymptotic analysis of the mean velocity at large Hartmann number are included. (M.H.R.)

21651 VELOCITY MEASUREMENTS AHEAD OF A SEMI-INFINITE BODY IN MAGNETOHYDRODYNAMIC FLOW WITH ALIGNED FIELDS. Lake, Bruce Meno. Pasadena, Calif.; California Inst. of Tech. (1969). 84p.

Thesis.

Experiments are described in which velocities were measured ahead of a semi-infinite Rankine body moving parallel to a uniform magnetic field in a conducting fluid. The flow disturbance in front of the body is found to increase in length as $N^{\frac{1}{2}}$, where N is the interaction parameter. In most of the experiments this parameter was varied from 4 to about 50. Measurements made along the axis of symmetry in the flow show that there is a relatively short region of stagnant fluid directly ahead of the body. The major part of the disturbance is found to consist of a much longer region in which the flow undergoes transition from conditions in the free-stream to conditions near the body. Velocity profiles across the flow in this region show that for increased N, at a fixed distance ahead of the body, the velocity defect increases and the disturbance becomes more confined radially. Although the radial gradients in the flow increase with N, they are found to be much smaller than would be expected in a flow containing thin current layers. A physical model of the flow which has currents and pressures consistent with these results is discussed. (Disser. Abstr.)

21652 EXPERIMENTAL INVESTIGATION OF MAGNETO-AERODYNAMIC FLOW AROUND BLUNT BODIES. Kranc, Stanley Charles. Evanston, Ill.; Northwestern Univ. (1969). 166p.

Thesis.

The drag forces on a body with a self-contained electromagnet are measured when the body is placed in a low-density argon plasma stream. Tests are conducted in a steady flow of plasma produced in a direct current arc and expanded to supersonic speeds. Measurements are restricted to one flow condition where the influence of viscosity and the Hall effect are both important. From experimental measurements of the total drag on the body, the Lorentz force on the magnet and the pressure force on the body, the viscous forces on the body may be deduced. Empirical relations for the data are then generated. It is found that the total drag and Lorentz force increase with increasing magnetic field but that the pressure and viscous forces decrease. A surprising result is that the pressure is found to increase at the stagnation point contrary to previous predictions. The experimental results are compared to existing theoretical treatments of the problem. A discussion on methods for bringing theory and experiment into closer agreement is given. The flow field around the body is investigated spectroscopically, and the predicted increase in shock stand-off distance is observed photographically. An unexpected visible color change which occurs when the magnetic field is applied is also investigated. Spectroscopic measurements show that the electrons in the plasma are out of thermal equilibrium in the plasma and the flow is essentially nonreacting. The influence of these facts on other experimental measurements is considered. (Disser. Abstr.)

21653 THE STABILITY OF AN INFINITELY CONDUCTING CYLINDER IN THE PRESENCE OF A MONOTONIC MAGNETIC FIELD. Narasimha Murthy, S.; Bhat, P. K. (Indian Inst. of Science, Bangalore). J. Indian Inst. Sci.; 51: 406-18(Oct 1969).

The stability of an infinitely long gravitating cylinder of incompressible, inviscid fluid of infinite electrical conductivity in the presence of a magnetic field having toroidal as well as poloidal components is discussed. The toroidal component is a monotonic function of the radial coordinate. By employing the energy principle and normal mode analysis, the results were compared. The results seem to be in good agreement. The general conclusion is that in every case the magnetic field increases the stability of the cylinder. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 21480, 21579, and 21622.

21654 COLLISION FREQUENCY OF ELECTRONS IN THE F REGION. Setty, C. S. G. K.; Jain, A. R.; Vyawahare, M. K. (Univ. of Delhi). Can. J. Phys.; 48: 653-8(15 Mar 1970).

The collision frequency of electrons in the F region of the ionosphere was measured at Delhi (geographical latitude 28°38′N, geographical longitude 77°13′E) using a method similar to that suggested by Appleton. The amplitude and group path of short radio waves vertically incident on the F region of the ionosphere were measured simultaneously at a suitable frequency (for both the ordinary and extraordinary wave modes) in early morning and late evening hours, corresponding to times of appearance and disappearance of the echo, respectively. Simultaneous changes in amplitude and group path are related to deduce the collision frequency. Some selected records taken near the time of sunrise have been analyzed and the values of collision frequency are found to be $(4.2 \pm 0.5) \times 10^3$ and $(3.5 \pm 0.5) \times 10^3\ s^{-1}$ for the ordinary and extraordinary waves, respectively, in the true-height range of 270 to 310 km. (auth)

21655 PROPAGATION OF GAMMA RADIATION IN THE UPPER ATMOSPHERE. Karpov, O. N.; Strelkov, A. S. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 599-600(1969).

Translated from Geomagn. Aeron.; 9: 742(1969).

The field of singly scattered radiation from an isotopic point source at heights from 10 to 60 km is computed at observation points at angles 0, ±45, and ±90° to the direction perpendicular to the density gradient. In the computations the atmosphere is taken to be plane and density to vary exponentially. The exponent was selected depending on the height of the source from the condition of the best approximation to the real atmosphere in a layer approximately corresponding to one length of the mean free path of the radiation of the source. (W.D.M.)

21656 DISTRIBUTION OF ELECTRON CONCENTRATION IN THE OUTER PART OF THE F_2-REGION UNDER QUIET AND DISTURBED CONDITIONS. Fatkullin, M. N.; Legen'ka, A. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 600-2(1969).

Translated from Geomagn. Aeron.; 9: 743-5(1969).

The space–time distribution of electron concentration in the outer part of the F2 layer was investigated previously on the basis of the results of topside soundings of the ionosphere from the Alouette 1 satellite. But the influence of magnetic activity and other factors, especially under average conditions, on the N(h) distribution in the outer part of the F2 layer was less closely investigated. The effect of magnetic activity on electron concentration in the F2 layer is analyzed statistically. (W.D.M.)

21657 TEMPERATURE DEPENDENCE OF THE PHOTOIONIZATION RATE IN THE UPPER ATMOSPHERE. Muradov, A.; Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 602-4(1969).

Translated from Geomagn. Aeron.; 9: 746-8(1969).

A BESM-3M computer was used to calculate the photoionization rates of the atmospheric components O, N_2, and O_2 at heights from 120 to 1000 km with allowance for the sphericity of the Earth and the diurnal variations of the structural parameters of the upper atmosphere. The computations were made for various zenith angles of the Sun at solar minimum and maximum. (W.D.M.)

21658 DETERMINATION OF INTEGRAL ELECTRON CONCENTRATION. Fligel, M. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 604-6(1969).

Translated from Geomagn. Aeron.; 9: 751-3(1969).

$\bar{N}$ values were computed for ionograms obtained on Alouette 1. The computations were made on the assumption that the virtual height is measured with an accuracy of ±5 to 10 km, the true height with an accuracy of ±1 km, and that the sounding and gyrofrequencies are known with an accuracy of ±0.1 MHz. The results of the computations are presented. (W.D.M.)

21659 INFLUENCE OF THE RING CURRENT ON THE POSITION OF THE AURORAL ABSORPTION ZONE. Zhulina, E. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 606-7(1969).

Translated from Geomagn. Aeron.; 9: 751-2(1969).

Results obtained confirm the influence of the ring current on the position of the auroral absorption zone and can serve as an explanation for the shift of the zone in different years at high, but equal ΣK_p values. It is assumed that in those cases when the zone does not shift at $\Sigma K_p < 25$ in various periods with the same ΣK_p values, the ring current is not intense enough. (W.D.M.)

21660 NATURAL PERIODS OF TOROIDAL OSCILLATIONS OF THE MAGNETOSPHERE. Bryunelli, B. E.; Namgaladze, A. A. (Leningrad State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 617-19(1969).

Translated from Geomagn. Aeron.; 9: 763-5(1969).

A general expression is obtained for the periods of toroidal oscillations when the WKB approximation is inapplicable. The problem is solved by the method of perturbations. (W.D.M.)

21661 PROPAGATION OF LOW-FREQUENCY HYDROMAGNETIC WAVES, GUIDED BY THE GEOMAGNETIC FIELD, THROUGH A GYROTROPIC IONOSPHERE. Van'yan, L. L.; Abramov, L. A. (Inst. of Space Research, Moscow. Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 620-1(1969).

Translated from Geomagn. Aeron.; 9: 766-7(1969).

Expressions are obtained that correspond to a dipole field with a moment $2I(\Sigma_2/\Sigma_1)$, perpendicular to the moment of the primary field. The intensity of variations at the surface of the Earth is proportional to the ratio of Hall to Pedersen conductivities. (W.D.M.)

21662 NEW EVIDENCE OF A RELATIONSHIP BETWEEN MAGNETIC FIELDS IN SPACE AND ON EARTH. Mansurov, S. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 622-3(1969).

Translated from Geomagn. Aeron.; 9: 768-9(1969).

The purpose of the investigation was to find new evidence of the existence of a relationship between the magnetic fields of the solar plasma and of the Earth. Some preliminary results are reported. (W.D.M.)

21663 RELATIONSHIP BETWEEN THE AZIMUTHAL (EASTERLY) COMPONENT OF THE INTERPLANETARY ELECTRIC FIELD AND GEOMAGNETIC FIELD VARIATIONS IN POLAR REGIONS. Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 623-5(1969).

Translated from Geomagn. Aeron.; 9: 770-1(1969).

The relationship between hourly variations of the easterly component of the interplanetary electric field, computed from Explorer-28 and Vela-3 data, and hourly geomagnetic field variations at Alert and Vostok during the magnetic disturbance of Sept. 26-29, 1966, was examined. (W.D.M.)

21664 TENDENCY OF GEOMAGNETIC FIELD PULSATIONS TO RECUR. Gogatishvili, Ya. M. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 627-9(1969).

Translated from Geomagn. Aeron.; 9: 774-6(1969).

According to Kato and Akasofu (1956), geomagnetic pulsations appear as a result of the interaction of solar corpuscular streams with the geomagnetic field. Therefore, it can be expected that geomagnetic pulsations have a tendency to recur every 27 days. The purpose of this study was to investigate this problem on the basis of data from M'Bour, Alma-Ata, and Dusheti. The recurrence of Pc 3 was studied at all stations and that of Pc 4, Pi 1, and Pi 2, only at Dusheti. (W.D.M.)

21665 SPHERICAL ANALYSIS OF THE GEOMAGNETIC FIELD FROM ANGULAR DATA AND THE EXTRAPOLATED g^0_1 VALUE. Braginskii, S. N. Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 629-31(1969).

Translated from Geomagn. Aeron.; 9: 777-8(1969).

The problem of how to best supplement the angular data available for the 16th and 17th centuries to permit analysis is generally complex. Here the following possibility is suggested: The largest of the coefficients g^0_1 does not vary too strongly over 200 years, (approximately 10%). The existing analyses reveal a nearly linear variation. It can be represented approximately in the form $g^0_1(t) = -30{,}400 + 15.7(t - 1960)$, where G^0_1 is in gammas and t is in years. (W.D.M.)

21666 EQUILIBRIUM CONFIGURATIONS OF A PLASMA IN THE MAGNETIC FIELD OF A TWO-DIMENSIONAL DIPOLE. I. Vo Hong An; Tverskoi, B. A. (Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 486-92(1969).

Translated from Geomagn. Aeron.; 9: 599-607(1969).

The problem of the equilibrium configurations of diamagnetic plasma blobs in the magnetic field of a dipole is solved in a two-dimensional case. Expressions are found for the boundary of a configuration coinciding with a magnetic line of force. The behavior of this boundary is analyzed for various pressures as compared to the local magnetic pressure of the undisturbed field. (auth)

21667 RADIOACTIVITY OF COSMOS 6 AND THE PRESUMED SITES WHERE RADIOACTIVE FRAGMENTS WERE COLLECTED AT A HEIGHT OF 300 TO 350 KM. Shafer, Yu. G.; Gal'perin, Yu. I.; Kuulagin, A. G.; Bolyunova, A. D. (Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 493-5(1969).

Translated from Geomagn. Aeron.; 9: 608-12(1969).

The Cosmos-6 data are used to refine the picture of the spatial distribution of the products of a high-altitude thermonuclear explosion. Data are obtained on the lifetime of a localized "contaminated" region at a height of 300 to 350 km at a magnetically conjugate point. (auth)

21668 MEASUREMENT OF THE TEMPERATURE OF IONS IN A RAREFIED MULTICOMPONENT PLASMA. Ponomarev, V. N.; Trifonov, Yu. M.; Zosimov, V. V. (All-Union Inst. of Electromechanics, Istra, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 506-9(1969).

Translated from Geomagn. Aeron.; 9: 625-9(1969).

A method of determining the temperature of ions in a multicomponent, rarefied plasma by means of a long ion tube is discussed. The results of an experimental verification of this method are reported. (auth)

21669 SOME CHARACTERISTICS OF THE REDISTRIBUTION OF CHARGED PARTICLES IN THE IONOSPHERE IN THE PRESENCE OF WIND SHEARS. Gershman, B. N.; Ignat'ev, Yu. A. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 510-14(1969).

Translated from Geomagn. Aeron.; 9: 630-6(1969).

The vertical electron concentration distributions in the ionosphere in the presence of horizontal winds with velocity shifts are obtained. The limitations imposed in investigations on the theory of E_s formation are not used in the computations. When changing to the F region, several differences from known, earlier results appear. Note is made of the specific conclusions derived from the theory of wind shear as applied to a narrow zone directly bordering on the geomagnetic equator. (auth)

21670 DISPERSION OF MAGNETOHYDRODYNAMIC WAVES IN THE IONOSPHERE. Khantadze, A. G. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 515-18(1969).

Translated from Geomagn. Aeron.; 9: 637-41(1969).

The gyrorelaxation effect of the attenuation of magnetohydrodynamic waves in the ionosphere is examined. It is shown that determination of the absorption of MHD waves in a relaxing ionosphere actually reduces to finding the anomalous absorption of acoustic waves. (auth)

21671 DYNAMICS OF INHOMOGENEITIES OF FAST ELECTRONS AND IONS IN THE EARTH'S MAGNETOSPHERE. II. Gurevich, A. V.; Tsedilina, E. E. (Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 519-25(1969).

Translated from Geomagn. Aeron.; 9: 642-9(1969).

The equations derived previously that describe the dynamics of an inhomogeneous cloud of fast electrons and ions trapped in the geomagnetic field are investigated. A dimensionless parameter λ, proportional to the density of fast particles and determining the influence of an electric field on the motion of an inhomogeneity, is found. A simple solution is obtained for $\lambda \to 0$ describing the motion and spreading of the inhomogeneity. It is shown that an inhomogeneity of fast particles spreads in this case and transforms into a radiation belt within ~2 to 3 periods of revolution of these particles around the Earth. The development of small disturbances is examined and the stability of the problem is investigated. (auth)

21672 GENERATION OF IONOSPHERIC DISTURBANCES BY VARIABLE CURRENTS AT POLAR LATITUDES. Grigor'ev, G. I.; Dokuchaev, V. P. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 526-9(1969).

Translated from Geomagn. Aeron.; 9: 650-5(1969).

The generation of internal gravity waves by time-variable electric fields in the upper atmosphere at polar latitudes is examined. Computations are performed for an isothermal atmosphere with a ring current. (auth)

21673 DYNAMIC MODEL OF THE IONOSPHERIC F REGION, INCLUDING TEMPERATURE VARIATIONS. Klimov, N. N.; Polyakov, G. I.; Gershengorn, G. I.; Kuznetsova, G. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR. Irkutsk State Univ., USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 530-4(1969).
Translated from Geomagn. Aeron.; 9: 656-60(1969).

Continuity and thermal balance equations are solved simultaneously for an electron–ion gas at minimum solar activity. Space–time variations in electron and molecular ion concentrations and in electron and ion temperatures are obtained for the height interval 120 to 1000 km. (auth)

21674 DETERMINATION OF THE AERONOMIC PARAMETERS OF THE IONOSPHERIC F-REGION. Rodionova, V. T.; Danilkin, N. P.; Chavdarov, S. S. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 535-8(1969).
Translated from Geomagn. Aeron.; 9: 661-5(1969).

A method of determining the height–time variations of aeronomic parameters of the nighttime ionospheric F region is examined. A sample computation of aeronomic parameters is given for 260 and 270 km (night) under conditions close to the solar activity maximum. (auth)

21675 INTERATMOSPHERIC MIGRATION AND DISSIPATION OF H AND He UNDER THE EFFECT OF MHD WAVES. Krasovskii, V. I. (Inst. of Atmospheric Physics, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 557-9(1969).
Translated from Geomagn. Aeron.; 9: 689-92(1969).

The possible escape of light H and He atoms from the atmosphere under the effect of magnetohydrodynamic oscillations at the exosphere boundary is examined. Oscillating ions essentially do not interact with neutral atoms in the exosphere. However, effective charge exchange of ions with their escape to near-Earth space or their transport to higher latitudes is possible at the exosphere boundary. Upon deeper penetration into the atmosphere, the recharged ions can no longer dissipate and migrate from the charge-exchange site since their energy is lost on the way to the exosphere boundary. (auth)

21676 PCA IN JULY, AUGUST, AND SEPTEMBER 1966, ACCORDING TO OBSERVATIONS IN THE AURORAL ZONE. Belikovich, V. V.; Benediktov, E. A.; Rapoport, Z. Ts. (Gorky State Univ., USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 539-44(1969).
Translated from Geomagn. Aeron.; 9: 666-73(1969).

The results are reported of measurements of anomalous cosmic radio noise absorption in the ionosphere during PCAs that followed the proton flares of July 7, August 28, and September 2, 1966. It is shown that the southern boundary of the injection zone of the corpuscular stream responsible for the PCA of July 7 was located in the vicinity of Loparskaya ($\Phi' \sim 64°$). This boundary shifted to latitude $\Phi' \sim 60°$ during the PCA of September 2–5. Diurnal variations were observed in the intensity of ionizing radiation at latitude $\Phi' \sim 64°$ on September 2–5. These variations were manifest in a decrease in ionization in the post-midnight hours (local time) and an increase after sunrise. The pattern of the frequency dependence of absorption at twilight indicates marked changes in the energy spectrum of a corpuscular stream from day to day. (auth)

21677 CONCERNING A CHARACTERISTIC FEATURE OF THE RELATIONSHIP BETWEEN SOLAR-WIND VELOCITY AND GEOMAGNETIC ACTIVITY. Mansurov, S. M.; Mansurova, L. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 560-2(1969).
Translated from Geomagn. Aeron.; 9: 693-6(1969).

Empirical equations describing the relationship between geomagnetic activity ΣK_p and solar-wind velocity V are examined. It is shown that the difference in the relationship between ΣK_p and V measured on Mariner II and IMP I is explained not only by the possible discrepancy between the readings of instruments on these spacecraft, but also by a change in the properties of the magnetosphere. (auth)

21678 FAMILIES OF GEOMAGNETIC STORMS FROM 1957 TO 1964. II. 27-DAY RECURRENCE OF GEOMAGNETIC STORMS WITH SUDDEN AND GRADUAL COMMENCEMENTS. Afanas'eva, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 9: 563-4(1969).
Translated from Geomagn. Aeron.; 9: 697-9(1969).

The 27-day recurrence of geomagnetic storms includes all storms regardless of the type of their commencement, i.e., storms with gradual and sudden commencements are recurrent. Recurrence is associated with the 11-year solar activity cycle; it is maximal in years with decreasing and minimum activity for storms with gradual and sudden commencements. (auth)

21679 MECHANISM OF PEARL GENERATION AND DEVELOPMENT DURING CYCLOTRON INSTABILITY OF THE OUTER PROTON ZONE. Feygin, F. Z.; Yakimenko, V. L. (Inst. of Terrestrial Physics, Moscow. Moscow State Univ.). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 565-9(1969).
Translated from Geomagn. Aeron.; 9: 700-5(1969).

The cyclotron instability of Alfvén waves in a plasma with an anisotropic distribution of hot protons is examined as a possible mechanism of generation of geomagnetic micropulsations of the pearl type. It is shown that the pearls must have the form of a nearly monochromatic wave packet whose frequency corresponds to the maximum increment. Some characteristics of the development of pearls with time are examined. (auth)

21680 POSSIBLE EXISTENCE OF STABLE CHARGED-PARTICLE BEAMS. Lyatskaya, A. M.; Lyatskii, V. B. (Polar Geophysical Inst., Kola, USSR). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 570-4(1969).
Translated from Geomagn. Aeron.; 9: 706-12(1969).

The possible autosynchronization of the motion of charged particles between magnetic mirrors is examined. Autosynchronization is produced by the space charge of a particle beam. This effect can be explained by the existence in the magnetosphere of relatively stable charged-particle beams, assumed in the interpretation of various geophysical phenomena. (auth)

21681 CONVERGENCE OF THE METHOD OF SUCCESSIVE APPROXIMATIONS IN THE PROBLEM OF SUPERSONIC FLOW AROUND A DIPOLE. Samokhin, M. V. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR)(Engl. Transl.); 9: 592-4 (1969).
Translated from Geomagn. Aeron.; 9: 735-7(1969).

The purpose of this study was to compare numerically three approximations in the external region of flow and to determine the boundary of the magnetosphere on the axis of symmetry. (W.D.M.)

21682 MOVEMENT OF AURORAS IN THE POLAR REGION. Fel'dshtein, Ya. I.; Lukina, L. V.; Belousov, B. G. (Arctic and Antarctic Scientific Research Inst., Antarctica). Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 122-4(Dec 1969).

Examination of auroral films at Vostok Station in 1965 revealed two types of movement of discrete polar-cap auroras, along and across the form, corresponding to movement in the Earth–Sun direction. Movement along the form describes the movement of the source of energetic particles responsible for the emission. Observations on discrete auroral forms in the polar region indicate movements of the source of energetic particles in the Earth-Sun direction at a rate of about 1.6 km/sec. Movement across the form was distinctly observed in thirty-one cases. The average rate of movement from the morning to the evening side was 128 m/sec and from the evening to the morning side 135 m/sec. Both directions of movement were equally frequent, none predominating over the other. Consequently, the source of energetic particles in the magnetic field of the tail moves in a radial direction between the neutral sheet and the surface of the magnetosphere much more rapidly than it does in the transverse direction. The minimum observed rate of movement is about 40 m/sec and the maximum 30 m/sec. The low stability of polar auroras attests to the depletion of the source of energetic particles and to the appearance of a new source (disappearance of an aurora at one place and the appearance of another) or to the displacement of the source with geomagnetic lines of force to a distance exceeding in the field of view of the camera. The dimensions of the region where energetic particles exist were computed from an average speed of about 1.5 km/sec. This yields about 5 R_E for the linear dimensions of the region in the tail of the magnetosphere. The described drift of the lines of force in the tail of the magnetosphere toward the neutral sheet must lead to the movement of emission at ionospheric levels from the day to the night side. (BBB)

21683 A LAYER OF ENERGETIC ELECTRONS (>40 keV) NEAR THE MAGNETOPAUSE. Meng, C. I.; Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res.; 75: 1827-36 (1 Apr 1970).

It is found that the magnetopause is permanently covered by a layer of energetic electrons extending from the dayside of the magnetosphere to at least about 60 R_E downstream along the tail. The layer has a thickness of about 1 to 2 R_E. The flux of energetic electrons in this layer shows a clear dependence on the geomagnetic activity indicated by the 3-hour Kp index. These findings are based on the observations of energetic electron fluxes of IMP 1, IMP 3, and lunar-orbiting Explorer 35 satellites. (auth)

21684 OGO 3 OBSERVATIONS OF THE LYMAN-α INTENSITY AND THE HYDROGEN CONCENTRATION BEYOND 5 R_E. Mange, P.; Meier, R. R. (Naval Research Lab., Washington, D. C.). J. Geophys. Res.; 75: 1837-47(1 Apr 1970).

The intensity of Lyman α was measured from the OGO 3 spacecraft at altitudes from 5 to 19 R_E. The variation of intensity with distance reveals a mean hydrogen density at 50,000 km of about 20 atoms cm^{-3} for the summer 1966 epoch and negligible contribution to the signal from geocoronal hydrogen beyond 12 radii. An extraterrestrial background of some 750 Rayleighs was observed at apogee. Asymmetry of intensity variations on either side of apogee suggests an enhancement of the background from regions near the galactic plane, and correlation of the background with solar activity over a 40-day period suggests that a portion of the background is solar-related. (auth)

21685 LOW-FREQUENCY NOISE OBSERVED IN THE DISTANT MAGNETOSPHERE WITH OGO 1. Dunckel, N.; Ficklin, B.; Rorden, L.; Helliwell, R. A. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 1854-62(1 Apr 1970).

Two new types of low-frequency noise, designated "broadband" and "highpass," were detected in the distant magnetosphere by the vlf/lf experiment on the OGO 1 satellite. Broadband noise extends over the entire range of observations from 0.2 to 100 kHz and the intensity decreases with increasing frequency. It occurs in bursts having durations of a few minutes or less. It shows no connection with any of the expected plasma cutoff or resonance frequencies and is believed to be a nonpropagating disturbance generated in the vicinity of the satellite. Highpass noise extends from a characteristic low-frequency cutoff to above 100 kHz and occurs in bursts lasting tens of minutes. This cutoff has only been observed above 20 kHz. Above the cutoff the intensity shows little variation with frequency. Both types of noise are observed predominantly at L greater than 5 in or near the night hemisphere. The occurrence of both types of noise is highly correlated with the auroral electrojet index. Several times noise bursts began within 2 min of the onset of micropulsations in the polar region even though the satellite was near apogee (24 earth radii). The peak rms magnetic intensity in a highpass noise burst has a maximum of 8×10^{-5} γ $Hz^{-\frac{1}{2}}$ and averages 10^{-5} γ $Hz^{-\frac{1}{2}}$. In free space these magnetic intensities correspond, respectively, to 10^{-12} and 3×10^{-14} watt m^{-2} Hz^{-1}. The peak levels of both types of noise are 3 or more orders of magnitude stronger than emissions from extraterrestrial sources observed with interplanetary probes. (auth)

21686 AURORAL MICROPULSATION INSTABILITY. Coroniti, F. V.; Kennel, C. F. (Univ. of California, Los Angeles). J. Geophys. Res.; 75: 1863-78(1 Apr 1970).

A drift instability of Alfvén waves driven by the sharp electron thermal gradient at the inner edge of the electron plasma sheet is described. The analysis predicts a localized instability with wavelengths, perpendicular to the magnetic field, comparable with an ion-cyclotron radius and parallel wavelengths comparable with the length of field lines. The fastest growing wave should have a period of ≈10 seconds, consistent with observations of 5- to 15-second micropulsations observed during substorms. (auth)

21687 AURORAL EMISSION FROM $O_2(^1\Delta_g)$. Noxon, J. F. (Harvard Univ., Cambridge, Mass.). J. Geophys. Res.; 75: 1879-91(1 Apr 1970).

A large enhancement of the $O_2(^1\Delta_g - {}^3\Sigma_g)$ infrared oxygen band at 1.27 μ in <IBC II auroras is described. A comparison with N_2^+ band intensity suggests that the O_2 emission is too strong to be sustained by the electron flux responsible for N_2^+. Alternative sources of energy, such as chemical reactions and electric fields, are considered. (auth)

21688 SOME IONOSPHERIC PROPERTIES AT 1000 KILOMETERS ALTITUDE WITHIN AND NEAR THE AURORAL ZONE. Dyson, P. L. (Goddard Space Flight Center, Greenbelt, Md.); Zmuda, A. J. J. Geophys. Res.; 75: 1893-1901(1 Apr 1970).

Explorer 22 electrostatic probe measurements of electron density (N_e) and temperature (T_e) show that at 1000-km altitude the ionosphere within and near the auroral oval is characterized by relatively large latitudinal variations in both N_e and T_e. Electron density enhancements occur that vary from the order of 10 km to several hundred km in horizontal extent. They vary in magnitude from increases of 10% upward, and the N_e enhancements are larger at night. Smaller scale variations (~1 km) also occur in N_e. The degree of correlation between T_e and N_e varies because of the dynamic nature of phenomena occurring in the oval region. Simultaneous measurements of local magnetic field fluctuations in the oval show that often the ionosphere is most irregular in the region where magnetic disturbances occur. (auth)

21689 CONCERNING THE INFLUENCE OF ELASTIC SCATTERING ON PHOTOELECTRON TRANSPORT AND ESCAPE. Banks, P. M.; Nagy, A. F. (Univ. of California, La Jolla, San Diego). J. Geophys. Res.; 75: 1902-10(1 Apr 1970).

A theory of photoelectron transport that includes both elastic and inelastic collisional processes has been developed to describe the behavior of photoelectrons in the upper atmosphere. Explicit solutions to the transport equations are obtained for a sunlit exponential atmosphere in which local production occurs, and for a predawn exponential atmosphere in which an influx of photoelectrons arrives from a magnetically conjugate region. The results indicate that elastic scattering significantly reduces the rate of photoelectron escape from a sunlit atmosphere while maintaining the up/down isotropy to higher altitudes than would be possible if elastic scattering did not occur. With regard to a predawn atmosphere, a substantial fraction (~50%) of incoming photoelectrons are backscattered by means of elastic collisions. To illustrate a more realistic situation, the behavior of 28-eV photoelectrons in 750° and 1500°K model atmospheres is also discussed. (auth)

21690 IONIC COMPOSITION AND TEMPERATURE OVER ARECIBO. 2. Prasad, S. S. (Univ. of Florida, Gainesville). J. Geophys. Res.; 75: 1911-18(1 Apr 1970).

Results on the composition and temperature of the charged particles in the topside ionosphere over Arecibo, as obtained from the analysis of incoherent backscatter spectra gathered at the Arecibo Ionospheric Observatory during the period December 1965 through October 1967, are presented. Enhanced solar activity resulted in increased concentration of the heavier oxygen ions and thereby higher altitude for the $O^+ \rightarrow He^+$ and H^+ transition level. The oxygen ions were important over a larger altitude range in summer than in winter. On winter nights the oxygen ion concentration began to rise even before local sunrise and continued to build up to early afternoon hours. In summer, however, the O^+ concentration levels off within about two to three hours of sunrise. A marked altitude gradient in temperature existed during winter nights when some thermal nonequilibrium also was noticeable. In contrast, the entire ionosphere was practically isothermal during summer nights. (auth)

21691 EXCITATION OF PLASMA RESONANCES BY A SMALL PULSED DIPOLE IN A WEAKLY INHOMOGENEOUS PLASMA. Fejer, J. A.; Yu, Wai-Mao (Univ. of California, La Jolla, San Diego). J. Geophys. Res.; 75: 1919-25(1 Apr 1970).

The field of a small pulsed dipole in a slightly nonuniform plasma is calculated with the aid of WKB solutions and stationary-phase approximations. McAfee's explanation of the quasi-periodic amplitude fluctuation of decaying oscillations excited near the plasma frequency by topside sounders, in terms of a beat between two waves following different group paths, is thus confirmed. The amplitude is shown to be enhanced by the nonuniformity of the plasma; the decay with time follows at $t^{-\frac{1}{4}}$ law in contrast to the $t^{-\frac{1}{2}}$ decay in a uniform plasma. The treatment is restricted to a horizontally stratified ionosphere in which the satellite travels parallel to a horizontal magnetic field. (auth)

21692 VLF AND ELF PROPAGATION DURING SUDDEN IONOSPHERIC DISTURBANCES. Field, E. C. (RAND Corp., Santa Monica, Calif.). J. Geophys. Res.; 75: 1927-33(1 Apr 1970).

Results are presented of a theoretical analysis of the propagation of electromagnetic waves in the very-low-frequency and extremely-low frequency ranges in the Earth–ionosphere cavity during solar flares. The calculations, which are based on nominal models of ambient conditions and solar flare x-ray fluxes and spectra, result in mode-attenuation coefficients that are in good general agreement with observations. The propagation is enhanced relative to ambient conditions at elf and upper vlf frequencies but is degraded in the lower vlf range. This general behavior is quite insensitive to the details of the assumed x-ray spectrum; its main requirement is a sufficient concentration of x-ray energy in the 1- to 8-A wavelength band. This class of spectrum tends to cause a moderate lowering of the D region, accompanied by an increase in the height gradient of conductivity in the reflection region; this in turn causes the observed phenomena at elf and vlf during sudden ionospheric disturbances. (auth)

21693 AURORAL ACTIVITY NEAR BANFF, ALBERTA. Hoch, R. J. (Battelle-Northwest, Richland, Wash.); Carver, F. I.; Smith, L. L.; Clark, K. C. J. Geophys. Res.; 75: 1935-6(1 Apr 1970).

Auroral activity near Banff during the period April 1, 1968 to April 1, 1969, is summarized. The analysis is based on meridian spectrograph records. When only the clear nights are considered, [O I] 5777 A line intensities indicate no aurora on 47% of the nights, faint aurora on 19% of the nights, and distinct aurora on 34% of the nights, where 'no,' 'faint,' and 'distinct' mean (<0.5 kR), (0.5 to 1 kR), and (>1 kR), respectively. Frequency distributions of auroral activity with respect to Ap magnetic index suggest a magnetic ac-

tivity threshold and show that activity occurred on more than half of the clear nights for which Ap > 10 and on nearly all clear nights for which Ap > 32. (auth)

21694 MICROPULSATION STUDIES IN THE POLAR CAPS. Hessler, V. P.; Heacock, R. R. (Univ. of Alaska, College). Antarctic J. U. S.; 4: 225-6(Sep-Oct 1969).

Results of H and D component induction magnetometer measurements at Vostok, near the south geomagnetic pole, and at Kanak, Greenland, near the north geomagnetic pole are considered. A Z component was recorded at Vostok. Data are provided for incidence, amplitude, and polarization of micropulsations in the frequency range 0.001 to 1 Hz. Characteristics of magnetic micropulsations were studied at very high latitude and determinations made to what extent the significant magnetoconjugate relations regularly observed at lower latitudes are also observed at the geomagnetic poles. Extensive auroral zone and polar cap data from related programs have made it possible to study the propagation of micropulsations in the polar cap ionosphere. As structured Pc1 is known to originate on closed field lines, its incidence at the poles is dependent on horizontal propagation in the F region of the ionosphere, acting as a waveguide. Analysis of micropulsation data extending to the geomagnetic poles shows that the positive magnetoconjugate correlation so characteristic of the subauroral zone decreases progressively toward the higher latitudes. At the poles, coincidence of Pc regimes or separate bursts are observed only rarely. The Pc pulsations at the poles have a clear diurnal variation with a maximum ~2 hr before geomagnetic midday, and a marked decrease in amplitude and incidence during the local winter (polar night effect). A study of 0.1 to 2 Hz polar cap micropulsation activity shows a pronounced seasonal variation in incidence of structured Pc1 at the pole, it being 10 times as frequent in winter as in summer. This fact, together with the low amplitudes of the activity at the pole (less than $1/10$ that of the activity at the auroral zone) and the accepted theory of their source on closed field lines, indicate a pronounced seasonal variation in Pc1–2 propagation conditions to the pole. (BBB)

21695 POLAR CAP ABSORPTION IN ANTARCTICA IN JANUARY–FEBRUARY 1967. Khodzha-Akhmedov, Ch. L. Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 158-9(Dec 1969).

At Mirny Observatory in Antarctica at 05 h 00 m universal time (UT) on January 28, 1967 the ionosonde began to show enhanced absorption and from 11 h 00 m on, the total absence of reflections. After solar noise bursts were observed from 05 h 30 m to 08 h 30 m UT, absorption began to increase sharply (the intensity of the neutron component of cosmic rays also increased between 10 h 00 m and 14 h 00 m UT). A maximum absorption of 6.8 db was recorded at 01 h 00 m UT on January 29 at a frequency of 32 MHz. It decreased thereafter and had a marked diurnal variation because of solar control. This polar cap absorption (PCA) event, which lasted 13 days, occurred with a generally slightly disturbed magnetic field. Only a single magnetic sudden-commencement storm, lasting 24 hr, was recorded at Mirny on February 7. Vostok Station records show that during the PCA event the equivalent heights of absorbing regions fell to 47 Km (according to absorption data at frequencies of 30 and 20 MHz) and averaged 57-58 Km. The highest electron density of the anomalous ionization layer, observed during the absorption maximum, was 3100 e/cm^3. Electron density decreased on subsequent days and returned to its normal level of 100 e/cm^3 on February 9. The coefficient of the frequency dependence of absorption varied from 0.5 to 2.0. A 30% increase in the neutron component of cosmic rays was recorded at 12 h 00 m on January 28 and an increase of 5% was recorded from 10 h 00 to 11 h 00 m UT on February 2. A periodic decrease in the intensity of the neutron component occurred on the following days until February 9. A magnetic storm with a gradual commencement was recorded at the station at 12 h 20 m on February 4 and lasted until February 11. At Molodezhnaya Station solar noise bursts were recorded on January 28, as they were at Mirny, and absorption increased sharply thereafter. (BBB)

21696 TWILIGHT EFFECTS OF PCA TYPE ABSORPTION ACCORDING TO OBSERVATIONS IN THE ANTARCTIC. Driatskii, V. M. (Arctic and Antarctic Scientific Research Inst., Antarctica). Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 155-7(Dec 1969).

Analysis of twilight effects during polar cap absorption (PCA) was performed to help solve the problem of the nature of anomalous ionization in the lower ionosphere. Ionization during PCA is caused by the injection of energetic protons generated by the Sun during chromospheric flares. Having a high energy, the protons penetrate deep into the Earth's atmosphere where the collision frequency is fairly high, resulting in a relatively high degree of ionization causing intense radio-wave absorption. Measurements of this absorption reveals processes taking place in the D layer. It was found that absorption and consequently, the ionization density of the layer depend significantly on the illumination of this layer by the Sun. Daytime absorption exceeds that at night by a factor of 4 to 6, an effect known as solar control. It is attributed to the fact that the attachment of electrons to neutral particles, accompanied by the formation of negative ions, and photodetachment under the effect of solar-wave radiation, leads to the detachment of electrons from negative ions. Galactic noise records at Mirny Observatory on the nights from September 2 to 3 and 3 to 4, 1966 show a definite asymmetry in the pattern of variations of noise absorption at sunrise and sunset. Whereas absorption begins to increase when the height of the effective Earth's shadow is about 50 km, it decreases at sunset to its minimum until the effective shadow reaches a height of about 80 km. There is some delay in the morning as compared to the evening. At the same solar zenith angle, solar radiation in the evening apparently produces a more intense photodetachment effect than in the morning. The entire absorption curve for sunset is higher than for sunrise and all other phenomena are shifted about 2 to 3° toward smaller solar zenith angles at sunset with respect to sunrise. This shift corresponds to a delay time in the phenomena of about 1 hr. Whereas electron concentration begins to increase at sunrise when z is 96°, at sunset it continues to decrease until the zenith angle is nearly 101°. (BBB)

21697 CONJUGATE-POINT AURORAL STUDIES AT BYRD AND GREAT WHALE STATIONS. Millman, Peter M. Antarctic J. U. S.; 4: 231-2(Sep-Oct 1969).

Conjugate-point auroral research carried out at Byrd and Great Whale in cooperation with the ESSA Research Laboratories in Boulder, Colorado, and the Arctic Institute of North America in Washington, D. C., is described. High-latitude conjugate-point studies are handicapped by the fact that, during most of the year, there is darkness at one conjugate point when there is light at the other. However, if periods of twilight (when the sun is more than six degrees below the horizon) are included, 1200 hr a year are available when the sky is dark simultaneously at Byrd and Great Whale. The periods of clear, dark sky at any one station will total less than half the above figure, however, and the periods of clear, dark sky simultaneously at both stations will be very much less. The identical auroral instrumentation operated at both stations consists of an auroral photometer utilizing a photomultiplier tube, and two all-sky cameras. During 1968 there were 100 hr when the sky was clear at both ends of the field line, and the prime records obtained during these periods are being analyzed to determine variations in the degree of conjugacy between the two stations. Future plans call for a network of auroral photometer stations around Great Whale to enable more detailed studies of how the field line passing through Byrd fluctuates at the northern end with the changing parameters of the Earth's magnetic field. (BBB)

21698 DOPPLER RADIO SOUNDINGS OF THE ANTARCTIC IONOSPHERE DURING 1968. Davies, K.; Jones, J. E. Antarctic J. U. S.; 4: 227-9(Sep-Oct 1969).

The frequency perturbations of 6-MHz radio echoes were recorded continuously during the period November 1967 through November 1968 over several paths originating at the South Pole. One objective was to determine the velocities of large-scale traveling ionospheric disturbances by means of space and time correlations. However, because of the diffuse character of the antarctic Doppler-frequency records, such correlations were not possible. During the day in late summer, the signal is reflected from a stable E layer at a height of about 100 km, whereas during the night, reflection is from the F layer (~250 km). The F layer echo is usually spread and essentially structureless, especially during winter. Sometimes it contains a central core. The frequency spreading of F-region echoes is associated with rapid amplitude fluctuations or fading of the radio signals. The symmetrical frequency spreading can be explained by a perfectly rough ionospheric model moving horizontally. With this model, weak reflections are obtained from a relatively large area of the ionosphere. The reflecting centers moving towards the path's midpoint will give rise to positive frequency shifts, and those receding will give rise to negative shifts. When the ionosphere is not perfectly rough, the echo will consist of a spread spectrum superimposed on a specular component. (BBB)

21699 SOLAR WIND INTERACTION WITH THE GEOMAGNETIC FIELD. Wolfe, John H.; Intriligator, Devrie S. (Ames Research Center, Moffett Field, Calif.). Space Sci. Rev.; 10: 511-96(Feb 1970).

Interaction of the solar wind with the magnetic field of the Earth is reviewed. The material is developed primarily from an observational point of view. The early observations are covered through late 1963, with primary emphasis on the sunward interaction re-

gion. The historical review of the early results is discussed in terms of the significant contributions of each satellite observation and in the light of the present concept of the solar wind–geomagnetic field interaction. Subsequent to 1963 the observations tend to overlap such that a strictly historical treatment is not tractable and the material is presented from a phenomenological approach. The daytime and nighttime hemispheres are covered separately in terms of the significant and separable phenomena which dominate the structure and dynamics of these two regions. Satellite and deep space probe data are compared with relevant theory. Further observational efforts needed to improve the understanding of the details of the solar wind–geomagnetic field interaction are also discussed. (auth)

21700 OBLIQUE IONOSPHERIC RADIOWAVE PROPAGATION AT FREQUENCIES NEAR THE LOWEST USABLE HIGH FREQUENCY. Jones, T. B. (ed.). AGARD Conference Proceedings, Number Thirteen. Slough, Eng.; Technivision Services (1969). 560p.

This volume is the proceedings of the XI Technical Meeting of the AGARD Electromagnetic Wave Propagation Committee held at the Univ. of Leicester. Thirty-eight papers were contributed on various facets of this wide subject. The papers cover the radiation phenomena in the 1- to 30-Mc band and, particularly, the problems of forecasting the lowest usable high frequency. Papers detailing methods of studying the structure of the lower ionosphere are supplemented by specialist papers on ray tracing, mathematical models, Doppler techniques, etc., together with recorded observations from specific sites. (W.D.M.)

21701 COLLISIONLESS ELECTROSTATIC SHOCKS. Andersen, H. K. (Danish Atomic Energy Commission Research Establishment, Risoe); Andersen, S. A.; Jensen, V. O.; Nielsen, P.; D'Angelo, N. Phys. Fluids; 13: 1106-8(Apr 1970).

An attempt was made in the laboratory to observe the standing collisionless electrostatic shocks described by Tidman in connection with the bow shock of the earth. (auth)

21702 AURORAL-TYPE E_s OVER THE SOUTH GEOMAGNETIC POLE. Besprozvannaya, A. S.; Sidorova, M. A. (Arctic and Antarctic Scientific Research Inst., Antarctica). Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 116-19(Dec 1969).

Vertical ionospheric sounding at Vostok Station (78.5° S, 10.9° E) show the flat type of E_s to be the predominant type of sporadic-E-layer ionization. The flat type is distinguished by the absence of group delay on the high-frequency end of the trace and in this case the virtual height of the trace does not vary with frequency. Along with the flat type of E_s, a few E_s reflections are observed at Vostok Station, which are designated as E_s of the n-type (nonclassifiable). Less than 40% of the auroras were accompanied by auroral-type sporadic ionization. This is apparently associated with the fact that most of the auroras in the polar region form at heights greater than the E layer, at the level of the F_2 layer. The dependence of the occurrence of auroral-type E_s on the time of day is poorly defined. E_s shows a tendency to appear most frequently in the pre-midnight hours local time (15 h UT). Auroral-type sporadic ionization, detected over the South Geomagnetic Pole, are interpreted as the injection of energetic electrons into ionospheric levels, since there is a similarity in the morphology of electron bursts and E_s at Vostok Station. Auroral-sporadic ionization events are much more frequent on magnetically quiet than disturbed days. This may be associated with the fact that when the dynamic effect of the plasma on the magnetosphere increases during magnetic disturbances so does the turbulence in the tail of the magnetosphere at very great distances from the earth (the corresponding magnetic lines of force intersect the surface of the earth in the polar cap at $\Phi > 80°$). Therefore, reconnection of the lines of force becomes impossible and, consequently, acceleration of charged particles in the tail of the magnetosphere also becomes impossible. (BBB)

Low-Temperature Physics

Refer also to abstracts 21374 and 21426.

21703 THEORY OF DEGENERATE AND NONDEGENERATE BOSE FLUIDS AND CALCULATION OF THE PAIR DISTRIBUTION FUNCTION. Morita, Tohru (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), Suppl.; No. 44, 69-117(1969).

A diagram formalism applicable to the degenerate Bose fluids was developed previously. This formalism has been applied to show that the long distance $1/r$ and $1/r^2$ behaviors of the pair distribution function are exactly cancelled for interacting Bose fluids. The basic ideas of the formalism have been given previously. The formalism is presented here in a unified form. The formalism is developed in the canonical ensemble. However the generating function is used. Hence a criterion of the equivalence of the canonical and grand canonical ensembles is given and used in the discussions. Replacement of operators a_0 and $a_0^\dagger$ by a c-number $n_0^{\frac{1}{2}}$ is performed with the same degree of care as Krommninga and Bolsteri took in treating the zero-temperature problem. Hugenholtz and Pine's relation is generalized to finite temperatures. The cancellation of the long-distance $1/r$ and $1/r^2$ behaviors at and below the λ temperature is briefly discussed. (auth)

21704 ANALYTIC PROPERTIES OF THE ONE- AND TWO-PARTICLE DISTRIBUTION FUNCTIONS OF BOSE FLUIDS. Hara, Hiroaki; Morita, Tohru (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), Suppl.; No. 44, 118-43(1969).

The one- and two-particle distribution functions of the ideal Bose gas and the hard sphere Bose gas are analyzed. The distribution functions of the ideal Bose gas are expanded in two forms which are useful for the cases of $r \gg \lambda_T$ and $r \ll \lambda_T$, respectively. The analysis for the hard sphere gas is performed in the chain approximation or the Bogolyubov approximation. Asymptotic forms are given for the various limiting cases separately, where the cases are classified by the relative magnitudes of λ/R_c, λ_T/R_c and unity. (auth)

21705 THEORY OF THE SURFACE OSCILLATIONS OF SUPERFLUID HELIUM AT LOW FREQUENCIES. Seiden, Joseph (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 270: 437-40(16 Feb 1970). (In French).

The general dispersion relation of the surface oscillations of superfluid helium was established. For low frequencies, the simplified relation obtained does not contain thermal conductivity. It is shown that oscillating temperature gradients are associated with the surface oscillations of a superfluid. (FRANCE)

21706 SUPERCONDUCTING TRANSITION TEMPERATURE OF MERCURY WITH ADMIXTURES. Sulkowski, C.; Mazur, J. (Polish Academy of Sciences, Wroclaw). Acta Phys. Pol.; A37: 317-18(Feb 1970).

The measurements of the transition temperature T_c of pure mercury and mercury with admixtures were carried out. The decrease of T_c under the influence of zinc and indium admixtures is confirmed in accordance with Anderson's theory. (auth)

21707 SUPERCONDUCTORS AND THEIR APPLICATIONS. Renard, Michel; Marinet, Dominique (Ecole Polytechnique, Paris). Inter Electron.; 24: 97-102(Apr 1969). (In French).

Fundamental properties of superconductors are reviewed. These include resistivity, the Meissner effect, and the critical thermodynamic field. Superconductors of the second type are explained; coherence of superconducting electrons is noted. Applications discussed include the construction of superconducting gyroscopes, cryotrons, use of the Josephson effect, and attainment of high magnetic fields. Use of different materials for different applications is noted, the particular applications of Nb–Zr and Nb–Ti alloys and Nb_3Sn requiring different forms because of mechanical strength problems. Application of Nb–25% Zr to 55,000 gauss, Nb–48% Ti to 85,000 gauss, and Nb_3Sn above 85,000 gauss and formulation of coils with mixed composition is noted. Applications of the Centre d'Etudes Cryogeniques in devising standard coils (wire), cable coils, and homogeneous coils, with nominal fields between 20,000 to 70,000 oersteds, and exterior diameters from 50 to 200 mm, are reviewed. (BBB)

21708 DIELECTRIC PENETRATION OF LIQUID SOLUTIONS ^3He–^4He. Esel'son, B. N.; Ivantsov, V. G.; Novikov, P. S.; Shcherbachenko, R. I. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh.; 14: 1837-44(Nov 1969). (In Russian).

The dielectric penetration of liquid solutions ^3He–^4He was measured in the range of temperatures of 1.4 to 4.2°K and that of concentrations 0 to 100% ^3He at saturated vapor pressure, by the capacity method. The Clausius–Mossotti equation was used to calculate the density and thermal expansion coefficient. The liquid–vapor critical temperatures and the temperatures corresponding to the density maximum and λ point were determined by the peculiarities of temperature dependence of the dielectric penetration. The results obtained were compared with the data of other authors. (auth)

21709 EXACT MAGNUS-FORCE FORMULA FOR THREE-DIMENSIONAL FLUID-CORE VORTICES. Huggins, Elisha R. (Dartmouth Coll., Hanover, N. H. Los Alamos Scientific Lab., N. Mex.). Phys. Rev., A; 1: 327-31(Feb 1970).

The two-dimensional Magnus formula $\vec{f}_m = \rho(\vec{v}_s - \vec{V}_v) \times \vec{\kappa}$ can be extended to three-dimensional fluid-core vortices of arbitrary core structure by a precise redefinition of the stream velocity vector $\vec{v}_s$, vortex velocity vector $\vec{V}_v$, and circulation vector $\vec{\kappa}$. For example, $\vec{V}_v$ becomes the velocity, in a plane slicing the vortex core, of the "center of mass" of the vorticity. The exact three-dimensional formula is derived by analyzing the motion of vorticity

relative to the fluid particles—a relative motion caused by the action of nonconservative forces on the vortex core (e.g., the electric force on a charged vortex ring in superfluid helium). The analysis deals with the vorticity field $\vec{\omega} \equiv \vec{\nabla} \times \vec{v}$ and, thus, can lead to simple formulas and insights in cases where the velocity field $\vec{v}$ may be impossibly complicated. Examples introduced are the concept of a "conserved vorticity current," a possible classical mechanism for the creation or destruction of vortex lines in superfluid helium, and a simple technique for analyzing the effect of viscosity on the structure of a vortex core. (auth)

21710 VELOCITY OF SOUND, DENSITY, AND GRUENEISEN CONSTANT IN LIQUID ^{4}He. Abraham, B. M.; Eckstein, Y.; Ketterson, J. B.; Kuchnir, M.; Roach, P. R. (Argonne National Lab., Ill.). Phys. Rev., A; 1: 250-7(Feb 1970).

By measuring the pressure dependence of the velocity of sound, both the pressure dependence of the density and the Grüneisen constant u of liquid ^{4}He were determined. Measurements were made below 0.1 K and in the vicinity of 0.5 K. The determinations of the pressure dependence of the density agree quite well with that determined by Boghosian and Meyer, who used a capacitance bridge. Since the latter results rely on the validity of the Clausius–Mossotti relation and a pressure-independent electric polarizability, the present work can be interpreted as supporting both of these assumptions. It was found that $u(\rho_0) \equiv (\rho/c)dc/d\rho = 2.84$ under the vapor pressure at 0.1 K. Using this value of u to calculate the attenuation of sound according to a three-phonon mechanism, an attenuation of less than half the measured value was found. Thus, the present theory of sound attenuation must be incomplete. (auth)

21711 ENERGY-DISSIPATION THEOREM AND DETAILED JOSEPHSON EQUATION FOR IDEAL INCOMPRESSIBLE FLUIDS. Huggins, Elisha R. (Dartmouth Coll., Hanover, N. H. Los Alamos Scientific Lab., N. Mex.). Phys. Rev., A; 1: 332-7(Feb 1970).

The dissipation of energy in the flow of an ideal incompressible fluid is described by a theorem whose derivation relies upon the exact three-dimensional Magnus formula discussed previously. The theorem, which explicitly demonstrates the role of vortex motion in the process of energy dissipation, can be used to calculate the trajectories of vortices. Also derived is a detailed Josephson equation—an extension of Anderson's "new corollary in classical hydrodynamics"—that provides an exact non-time-average relation between chemical potentials and vortex motion. (auth)

21712 THE PAIR DISTRIBUTION FUNCTION IN THE THEORY OF THE GROUND STATE OF LIQUID ^{4}He. Lee, Monhe Howard. Philadelphia; Univ. of Pennsylvania (1969). 179p.

Thesis.

A Jastrow function was considered as the starting N-body wavefunction on the basis of the demands of the boundary conditions. The Jastrow function is composed of two-body functions which are approximate solutions of the two-body Schrodinger equation with the Lennard-Jones potential. To demonstrate the evident existence of stability one must calculate the ground state energy as a function of density. Utilization of the Jastrow function means, however, the necessity of explicitly knowing the pair distribution function. By using some of the methods developed for classical statistical mechanics, the pair distribution function is calculated, whose solutions are found to be physically based. The calculation of the ground state energy shows that there is a minimum at quite physical density in the energy-density relation, thereby indicating the existence of stability. To understand the role of a more generalized Bose–Einstein condensation one must know of a more generalized version of the pair distribution function. By exploiting formal correspondence between the classical pair distribution function and this more generalized version, it is shown that the generalized function depends on the Jastrow pair distribution function. The dependence is such as to suggest that the ground state energy will indeed be lowered when the generalized Bose–Einstein condensation is assumed. (TSS) (Diss. Abstr.)

21713 ANISOTROPY OF THE CRITICAL CURRENT IN A SINGLE CRYSTAL OF A SUPERCONDUCTING ALLOY Pb–In. Volotskaya, V. G.; Fogel, N. Ya. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 387-93(Feb 1970). (In Russian).

Anisotropy of the critical current of cylindrical single crystals of the superconducting alloys Pb–24 at. % In and Pb–12 at. % In is investigated in a broad range of field strengths $H_{c1} < H < H_{c3}$ and for various treatments of the surface. The long axis of the sample, along which the transport current is directed, coincides either with direction [100] or with direction [110]; the magnetic field is perpendicular to the current. Measurements of critical current anisotropy in etched samples show that the character of the anisotropy reflects the crystallographic symmetry of the sample. Critical current maxima are observed when the magnetic field is oriented along the directions ⟨100⟩, ⟨110⟩, and ⟨111⟩. The dependence of the anisotropy magnitude on magnetic field strength is studied. A major role in determining the magnitude of the critical current is played by surface pinning of the vortices and the anisotropy observed is related to the state of the surface layer of the single crystals. (auth)

21714 INVESTIGATION OF THE SUPERCONDUCTING PROPERTIES AND STRUCTURE OF TIN FILMS OBTAINED BY REACTIVE SPUTTERING. Golyanov, V. M.; Demidov, A. P.; Mikheeva, M. N.; Teplov, A. A. Zh. Eksp. Teor. Fiz.; 58: 528-34(Feb 1970). (In Russian).

The critical temperatures T_c, transverse critical magnetic fields $H_c^{\perp}$ and resistivities of microcrystalline tin films obtained by reactive cathode sputtering are measured. The relation between T_c and $H_c^{\perp}$ and the structure of films as studied with an electron microscope is investigated. It is found that increase of T_c and $H_c^{\perp}$ correlates with a decrease of the grain size. The electron mean free path l is determined on the basis of the resistance and magnetic measurements. The dependence of $H_c^{\perp}$ on l is compared with the theoretical calculation. (auth)

21715 EXCITATION SPECTRUM OF A PARAMAGNETIC-SUPERCONDUCTING CONTACT. Kuemmel, Reiner (Univ., Frankfurt am Main). Phys. Kondens. Mater.; 10: 331-41 (25 Feb 1970).

A calculation of the bound states in a paramagnetic-superconducting contact, valid at any temperature below T_c, is performed by using a recently developed method of solving the Bogolyubov equations. The problem of self-consistency of the pair potential $\Delta(x)$ is avoided by leaving open the detailed form of $\Delta(z)$, introducing instead the characteristic length for the spatial variation of the pair potential, $d = \int_0^D (1 - \Delta(z)/\Delta)dz$, as a fit parameter. The energies, the quasi-particle wave functions and the density of the bound states are calculated for negligible impurity scattering. The energy gap of the excitation spectrum reduces from about one third of its bulk values to practically zero as the thickness a of the normal film increases from $a \ll d$ to $a \gg d$. (auth)

21716 MECHANISM OF ULTRASONIC CAVITATION NUCLEATION IN LIQUID HELIUM BY QUANTIZED VORTICES. McConnell, P. M.; Chu, M. L. Jr.; Finch, R. D. (Univ. of Houston, Tex.). Phys. Rev., A; 1: 411-18(Feb 1970).

The interaction between an ultrasonic field and one or a few quantized vortex lines in He II was investigated using the audible cavitation threshold as a means of detection. Experiments involved both rotating ultrasonic buckets and two shafts, each with a paddle attached, rotatable in the same or opposite sense near an ultrasonic field. Histograms of cavitation threshold measurements were not Gaussian, but appeared to be dimodal. The high-threshold mode was most frequent in the quiescent state, but the lower mode was most frequent with rotation. The threshold values were found to fluctuate with time both with and without rotation. Slight and gradual reductions of audible threshold were observed in the rotating bucket sometimes, beginning at speeds less than that predicted by the Arkhipov–Vinen formula. Reductions at speeds higher than the Arkhipov–Vinen value were not directly proportional to the total number of vortices believed to be present in the bucket. Two shafts with paddles rotating in opposite senses caused larger reductions in threshold than a single shaft and paddle; but this was not the case when the shafts rotated in the same sense. (auth)

21717 TWO KINDS OF BOSONS AND BOSE CONDENSATES. Kohn, W.; Sherrington, D. (Univ. of California, San Diego, La Jolla). Rev. Mod. Phys.; 42: 1-11(Jan 1970).

Ordinary material systems whose elementary constituents are fermions are dealt with. It is pointed out that in such systems there can occur two kinds of bosons with quite different physical and mathematical characteristics. Type I bosons are bound complexes of an even number of fermions (such as ^{4}He); and type II bosons are elementary excitations which are bound complexes of fermions and their holes (such as excitons). When the first type condenses, a superfluid state results with so-called off-diagonal, long-range order; while when the second type condenses, there is no superfluidity, but a change in spatial order. Thus both kinds of long-range order are related to Bose condensation. (auth)

21718 BOSE–EINSTEIN CONDENSATION OF NONINTERACTING PARTICLES. Zinke, Otto Henry (Univ. of Arkansas, Fayetteville). Amer. J. Phys.; 38: 235-7(Feb 1970).

The chemical potential is determined for a Bose–Einstein gas of noninteracting particles in a closed system. The calculation is done in a manner which shows dependence on an energy gap $(\epsilon_1 - \epsilon_0)$, limits of application of the results, and behavior through the transition temperature. (auth)

21719 SIZE EFFECT ON MAGNETIZING HARD SUPERCONDUCTORS. Lazarev, B. G.; Ovcharenko, O. N. (Physical Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR; 189: 1218-21(21 Dec 1969). (In Russian).

Studies were performed on ternary niobium alloys with 25 to 28 wt. % Zr and 30 to 37 wt. % Ti, and on binary niobium alloys with 20 to 60 wt. % Ti or 25 wt. % Zr. Magnetization of the sample as a function of magnetic field (to fields of about 35,000 Oe in the superconducting solenoid) were determined by withdrawing the sample from the measuring coil at temperatures of 2 and 4.2°K. On decreasing the sample diameter of the thermally-treated wire from 0.23 to 0.17 mm, the magnetization practically does not change up to a field of about 4000 Oe, but the jumps with a change of field are very sharp. The field for the beginning of the jump is lowered to 3500 Oe. A diameter decrease to 0.13 mm leads to a strong decrease in magnetization to about one-fourth of the initial value and in the initial penetration field. Further size decreases lead to further decreases in magnetization. Single-phase alloys do not show a size effect, and this method may be used to distinguish single-phase superconductors from two-phase (or multiphase) superconductors. (TTT)

21720 ELECTRON TUNNELING INTO SUPERCONDUCTING MERCURY FILMS BELOW ONE DEGREE KELVIN. Hubin, Wilbert Norman. Urbana, Ill.; Univ. of Illinois (1969). 117p.

Thesis.

The tunneling characteristics of an aluminum/aluminum oxide/mercury junction have been measured at temperatures down to 0.35°K. Additional structure over that seen in an earlier, higher-temperature experiment is reported. The data have been analyzed through the use of a computer program based on the strong-coupling theory. The effective phonon spectrum and the complex energy gap function for mercury are thereby derived. Values for the electron self energy function, the electron renormalization function, Coulomb pseudopotential, and the electron-phonon interaction constant are also determined. (Diss. Abstr. Int., B)

21721 TOPICS IN TRANSPORT PHENOMENA NEAR THE CRITICAL POINT. Laramore, George Ernest. Urbana, Ill.; Univ. of Illinois (1969). 91p.

Thesis.

The mode–mode coupling theory of Kadanoff and Swift for the estimation of transport coefficients near the critical point is applied to the calculation of the electrical conductivity near the superconducting transition and to the calculation of the attenuation coefficient for longitudinal sound waves near the magnetic transition. The rise in the electrical conductivity as a material approaches its superconducting transition is described. Near T_c small regions become superconducting and can carry an anomalous current, thereby causing a rise in conductivity. The use of the Kubo formula permits the estimation of the contribution from this source. A comparison of this estimate with previous theories and experiment is carried out. The rise in the ultrasonic attenuation as a material approaches its magnetic transition is described. Near the transition small regions become magnetically ordered and their interaction with the sound wave is enhanced, thereby causing increased absorption of the sound. The Kadanoff and Swift formalism permits the estimation of this increased attenuation. Predictions are made of the increased attenuation in various models of magnetic systems. A comparison with experiment is carried out. (Diss. Abstr. Int., B)

21722 EXISTENCE OF ION MOBILITY DISCONTINUITIES IN SUPERFLUID HELIUM. Schwarz, K. W. (Univ. of Chicago). Phys. Rev. Lett.; 24: 648-51(23 Mar 1970).

Previous investigators have reported the existence, at certain values of the drift velocity, of discontinuities in the mobility of positive and negative ions in superfluid helium. A different experimental technique gives results which seem to indicate that such discontinuities are probably spurious. (auth)

21723 ULTRAVIOLET EMISSION SPECTRUM OF ELECTRON-BOMBARDED SUPERFLUID HELIUM. Stockton, M.; Keto, J. W.; Fitzsimmons, W. A. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 24: 654-7(23 Mar 1970).

The emission spectrum of electron-bombarded superfluid helium has been measured as a function of wavelength between 550 and 2500 Å. The spectrum is characterized by a very intense asymmetric band of continuous emission peaking at approximately 800 Å with half-width of roughly 150 Å, along with a series of less intense bands between the wavelengths of 620 and 710 Å. This continuum is due to the radiative dissociation of neutral He_2 molecules in the reaction $A^1\Sigma_u^+ \rightarrow X^1\Sigma_g^+$. (auth)

21724 SYNTHESIS, STRUCTURE, AND SUPERCONDUCTIVITY OF NEW HIGH PRESSURE PHASES IN THE SYSTEMS Ge–P AND Ge–As. Donohue, P. C.; Young, H. S. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Solid State Chem.; 1: 143-9(1970).

Reactions of Ge and P and As were run in a tetrahedral anvil press at conditions ranging from 600 to 1300 C and 15 to 65 kbars. Three new phases were found in the Ge–P system. Two phases of approximate formulas GeP_5 and GeP_3 have rhombohedral crystal structures related to the A7 arsenic type. The cell dimensions of GeP_5 are a = 3.467 (3) Å, c = 10.04 (1) Å and of GeP_3 a = 7.050 (1) Å, c = 9.932 (3) Å. The cell dimensions vary for different preparations indicating ranges of stoichiometry. A new tetragonal form of GeP was prepared by the reaction of Ge + 1.0 – 1.7 P at 600 to 800 C, 45 to 65 kbars. The cell dimensions are a = 3.544 (2) Å, c = 5.581 (1) Å and space group is 14 mm. A similar tetragonal phase was formed in the Ge–As system. The cell dimensions are: a = 3.715 (1) Å, c = 5.832 (1) Å. The tetragonal crystal structures were solved by least-squares refinement of the powder-diffraction intensity data. Bond distances and angles were calculated. Electrical measurements on single crystals show metallic behavior. Meissner effect measurements show that GeP is superconducting below 1.8 to 4.2 K and GeAs below 3 to 3.5 K. (auth)

21725 SUPERCONDUCTIVITY OF DILUTE INDIUM–THALLIUM ALLOYS. Gubser, Donald Urban. Urbana, Ill.; Univ. of Illinois (1969). 101p.

Thesis.

Critical field measurements on the In–Tl alloy system covering the concentration range of 0 to 7% thallium have been made. Since indium and thallium have the same number of valence electrons, the In–Tl alloy system should be free from valence effects. It is therefore well suited for studying anisotropy induced changes in superconducting properties. The critical temperatures were determined from an extrapolation of the critical field data near T_c, and the critical fields at T = 0 were determined from an extrapolation of the data below 1°K. Measurements down to T = 0.35°K were made to enable an accurate determination of γ, the temperature coefficient of normal electronic specific heat. No effect on γ due to alloying was observed. Changes in the quantities T_c, H_c/T_c, and $dH_c/dT)_{T=T_c}$ are compared to the anisotropy theory of Markowitz and Kadanoff and of Clem. Significant departures from theoretical predictions are observed. (Disser. Abstr.)

21726 STUDIES OF SUPERCONDUCTING LEAD FILMS: PROXIMITY EFFECTS AND FLUCTUATION EFFECTS ABOVE THE TRANSITION TEMPERATURE. Smith, Robert Owens. New Brunswick, N. J.; Rutgers–The State Univ. (1969). 118p.

Thesis.

Superconducting lead films were deposited onto substrates which were kept at liquid helium temperatures. These films were highly disordered and had very small electron mean free paths. Two basic experiments were performed on these disordered systems. First, the proximity effect of thin lead films in contact with a film of gadolinium, which is magnetic at low temperatures, was studied. Second, the effect of thermal fluctuations of the superconducting order parameter above the transition temperature was studied. The experimental results are discussed and compared with theory. (TSS) (Disser. Abstr.)

21727 MEASUREMENT OF SUPERCONDUCTING ENERGY GAP IN ULTRATHIN FILMS OF BISMUTH AND TIN. Wilson, John Paul. Evanston, Ill.; Northwestern Univ. (1969). 72p.

Thesis.

The magnitude of the energy gap in quench deposited bismuth and tin was determined for film thicknesses in the range 20 to 200 Å. The gap was obtained from the current–voltage characteristics of Al/Al_2O_3/superconductor tunnel junctions. These characteristics were measured as the crucial superconducting film was vapor deposited on a glass substrate held at 1.8°K. The energy gap was therefore determined when the bismuth or tin film was just continuous enough to carry a measuring current. Evidence for an energy gap in bismuth films less than 20-Å thick and in tin film 40-Å thick was presented. The magnitude of the bismuth energy gap was shown to increase with thickness below 200 Å, while the tin energy gap remained constant above 40 Å. The bismuth gap for different films thicker than 200 Å varied from 2.17 to 2.50 MeV, even though the deposition rate, temperature of substrate, and background pressure was held constant. It was suggested that the variation of the energy gap in amorphous bismuth films is related to mixtures of the different phases of high-pressure bismuth. (Disser. Abstr.)

21728 THE LOW-TEMPERATURE OSMOTIC PRESSURE OF DEGENERATE DILUTE LIQUID ^{3}He–^{4}He SOLUTIONS UNDER PRESSURE. Landau, Judah. Columbus, Ohio; Ohio State Univ. (1969). 196p.

Thesis.

The osmotic pressure of dilute liquid solutions of ^{3}He in ^{4}He

was measured as a function of temperature between 0.027°K and 0.65°K at ^{3}He concentrations up to 12% and pressures up to 20 atm. The experiment was performed using a dilution refrigerator. The osmotic pressure was measured directly with a specially constructed capacitive pressure transducer which resolved pressure changes of 1 micron Hg with negligible hysteresis. Data were obtained by varying the solution temperature while maintaining the pressure, P, and ^{3}He concentration, X, constant. By extrapolation π_0, the 0°K limit of the osmotic pressure, was obtained as a function of the concentration for P = 0.26, 10 and 20 atmospheres. When reduced to zero pressure, the results are in good agreement with the theoretical predictions of Bardeen, Baym, and Pines using the effective interaction potential V_k given by Baym and Ebner. The P = 0 value of π_0 in the phase-separated solution was found to be (16.9 ± 0.2) mm Hg. The minimum concentration for phase separation at 0°K (that is, X_0, the limiting solubility of ^{3}He in ^{4}He) was determined as a function of pressure. The extrapolated value of X_0 (P = 0) = (6.7 ± 0.15)% is in reasonable agreement with previous measurements. The curve of X_0 vs P has a maximum value of 9.5% near 10 atm. Supercooling was observed in two solutions with concentrations slightly greater than the limiting solubility. Single-phase osmotic pressures were measured down to temperatures which were about half the normal phase separation values. An excellent fit for the osmotic pressure as a function of temperature was obtained from a thermodynamic model. This made it possible to obtain fitted values of the ^{3}He quasi-particle effective mass, m*, as a function of pressure and concentration. Within experimental error, m* was found to be independent of X; the X = 0 limit of m*(P) agrees with the second sound measurements of Sandiford and Fairbank. (Disser. Abstr.)

21729 HIGH-TEMPERATURE SUPERCONDUCTIVITY. Georgiev, Georgi. Fiz.-Mat. Spis., Bulg. Akad. Nauk.; 12: No. 2, 125-36(1969). (In Bulgarian).

This is a survey of the field of the so-called high-temperature superconductivity, i.e., superconductivity at temperatures well above the liquid helium temperature. The description of the basic experimental results of conventional $T_c < 20$°K superconductivity is followed by a presentation of the Bardeen–Cooper–Schrieffer theory and a discussion of possible "sandwich"-type, organic radical, and other materials of the future which would be superconductive even at room temperature. (JPRS)

21730 GINZBURG–LANDAU EQUATIONS FOR THE CASE INVOLVING THE PRESENCE OF CURRENT IN A SUPERCONDUCTOR. Arutyunyan, R. M. (Physical Research Inst., Erevan). Dokl. Akad. Nauk SSR; 46: 172-5(1968). (In Russian).

V. L. Ginzburg and L. D. Landau derived an equation that specifies the free energy density of a superconductor near the critical temperature. On the basis of this relation, the energy balance of the superconductor was determined, assuming that a current was present in the system at a given magnetic field strength. The already-known expression for the free energy in an external magnetic field could be derived from this equation, assuming that the field sources are located outside of the superconductor. The equation may also be used to obtain the modulus of the wave function, specifying the condition for the uniform distribution of the current density. (TTT)

21731 COMPOSITE SUPERCONDUCTORS OBTAINED BY THE METHOD OF PHASE SUBSTITUTION IN ALLOYS. Savitskii, E. M.; Mikhailov, B. P.; Baron, V. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 189: 1226-9 (21 Dec 1969). (In Russian).

The method of substituting a low-melting eutectic has unique possibilities in producing superconductors with an inhomogeneous structure consisting of phases with different superconducting characteristics. Lead, lead alloys containing antimony and bismuth, and the insulating material polystyrene were used to replace the low-melting phase rich in tin that is associated with the refractory brittle compound Nb_3Sn found in niobium alloys with 60 to 65 wt % tin. Phase substitution was carried out by heating in an electric furnace below a temperature of 2000°C. Structural analyses indicate the phase substitution. A change in microhardness was observed, but the total hardness and compression strength did not change with phase substitution. The presence of two superconducting transitions is shown after phase substitution. In the case of replacing tin with lead or with a lead–antimony alloy, the first transition temperature is equal to 7.1°K, and on replacement with a lead-antimony alloy it is 8.3°K. The second superconducting transition temperature takes place at 17.5 to 17.8°K. In alloys replaced with polystyrene there is only one transition at 17.5 to 17.8°K. (TTT)

21732 SUPERCONDUCTIVITY AND THE PERIODIC SYSTEM. Matthias, Bernd T. (Univ. of California, San Diego). Amer. Sci.; 58: 80-3(Jan-Feb 1970).

The breakthrough leading to superconductivity at 21°K is shown to follow simple rules to be found in the periodic system. (auth)

21733 CURRENT CAPACITIES OF SUPERCONDUCTING V_3Ga TAPES IN HIGH MAGNETIC FIELDS. Tachikawa, K. (National Research Inst. for Metals, Tokyo); Iwasa, Y. Appl. Phys. Lett.; 16: 230-1(15 Mar 1970).

Current-carrying capacities at 4.2°K of various superconducting V_3Ga tapes produced by a new diffusion process were measured in transverse magnetic fields up to 215 kG. Effects of heat-treatment temperature and addition of zirconium are presented. (auth)

21734 BEHAVIOR OF SOLENOIDS IN TYPE-I SUPERCONDUCTING SHIELD TUBES. Schweitzer, Donald G.; Garber, M. (Brookhaven National Lab., Upton, N. Y.). Appl. Phys. Lett.; 16: 246-8(15 Mar 1970).

A model is described which accounts for the observed properties of solenoids in superconducting shield tubes. (auth)

21735 DESCRIPTION OF ELASTIC AND DIELASTIC INTERACTIONS IN SUPERCONDUCTORS BY QUASIDISLOCATIONS. Kronmueller, H.; Riedel, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi; 38: 403-7(1 Mar 1970).

The interaction between dislocations and the superconducting state is usually attributed to the ΔV effect, the ΔE effect, and to nonlinear elasticity effects. It is shown that all three types of interactions may be described in a unified manner in terms of quasidislocations. For the interaction forces between crystal dislocations and quasidislocations generated by the superconducting state, a generalized Peach–Koehler-type formula is derived. (auth)

21736 UPPER CRITICAL FIELD CHANGES IN ELECTRON-IRRADIATED NIOBIUM. Ullmaier, H.; Papastaikoudis, C.; Schilling, W. (Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi; 38: 189-92(1 Mar 1970).

Measurements are reported of the dependence of the upper critical field H_{c2} on the concentration and configuration of Frenkel defects in niobium. The defects were produced by low-temperature irradiation with 3-MeV electrons and subsequent annealing treatments. The results qualitatively confirm a theory by Eilenberger that predicts that H_{c2} not only depends on the electronic mean free path but also on the ratio between s- and p-wave scattering of the defects. (auth)

21737 STUDY OF THE PERMEABILITY OF THE EUTECTIC SUPERCONDUCTOR Cd–Sn WITH LAMELLAR STRUCTURE. Dobrosavljevic, L.; Petipas-Dupuis, C.; Racek, R. (Laboratoire de Physique des Solides, Orsay, France). Phys. Status Solidi; 38: 159-66(1 Mar 1970). (In French).

The rf surface permeability of lamellar Cd–Sn eutectic SNSN ... has been studied in the temperature range $T < T_{CNS}$ (T_{CNS} = critical temperature of the system as a whole, ~3.6°K). The magnetic field H is in the plane of the lamellae and the thickness of the Cd lamellae is greater than the coherence length. The measurements may be interpreted with the assumption that the flux penetrates in the form of a one-dimensional vortex array when H is about a certain (weak) critical field H_{c1}. (auth)

21738 STATISTICAL INTERPRETATION OF LONDON'S STRESS TENSOR. Pfleiderer, J. (Univ., Bonn). Phys. Rev., A; 1: 896-8(Mar 1970).

London's stress tensor of the phenomenological theory of superconductivity is identified with the pressure tensor of the gas of superelectrons. (auth)

21739 OSMOTIC PRESSURE OF DILUTE SOLUTIONS OF ^{3}He IN ^{4}He. Wilson, M. F.; Tough, J. T. (Ohio State Univ., Columbus). Phys. Rev., A; 1: 914-22(Mar 1970).

The osmotic pressure of dilute solutions of ^{3}He in liquid ^{4}He was measured at 0.32, 0.65, and 1.16°K for concentrations up to 2%. The technique does not require values of the ^{4}He fountain pressure and is substantially more precise than previous methods. The results are analyzed in terms of the effective-interaction model of Bardeen, Baym, and Pines as extended to nonzero temperatures by Ebner. The results do not agree well with the theory. (auth)

21740 ON THE THEORY OF SUPERCONDUCTORS WITH MAGNETIC IMPURITIES IN A SINGLET GROUND STATE. Fulde, Peter; Hoenig, H. E. (Univ., Frankfurt am Main). Solid State Commun.; 8: 341-3(Mar 1970).

A theoretical explanation of recent measurements of Bucher et al. (Helv. Physica Acta 41; 723(1968)) on superconducting systems containing rare earth impurities in a singlet ground state is given, and an additional experiment to demonstrate the importance of crystalline fields is proposed. (auth) (UK)

21741 HIGH-FREQUENCY FIRST-SOUND ATTENUATION NEAR THE λ TRANSITION OF LIQUID ^{4}He. Kawasaki, K. (Univ. of Illinois, Urbana). Phys. Lett.; 31A: 165-6(23 Feb 1970).

First-sound attenuation near the λ transition of liquid ^{4}He at the frequencies much higher than the characteristic frequency of order-parameter dynamics is studied theoretically. (auth)

21742 SUPERCONDUCTIVITY AND BAND STRUCTURE. Havinga, E. E.; Van Maaren, M. H. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett.; 31A: 167-8(23 Feb 1970).

It is shown that superconductivity can arise only if two bands of a different character are present at the Fermi surface or if the band is strongly deformed by Bragg planes near the Fermi surface. Metals with a simple and single band are not superconductors. (auth)

21743 FLUCTUATION OF THE ORDER PARAMETER IN A SUPERCONDUCTOR WITH MAGNETIC IMPURITIES. Nam, S. B. (Univ. of Virginia, Charlottesville). Phys. Lett.; 31A: 218-9 (23 Feb 1970).

Using the time-dependent Ginzburg–Landau equation for the order parameter in a superconductor with magnetic impurities, the effect of the fluctuation of the order parameter on the conductivity was calculated. It was found that the excess conductivity due to the fluctuation, "paraconductivity," increases with the strength of depairing. (auth)

21744 DYNAMICAL THEORY OF EVAPORATION FROM He II. Griffin, A. (Univ. of Toronto). Phys. Lett.; 31A: 222-3 (9 Mar 1970).

It is pointed out that the energy spectrum of evaporating atoms from He II appears to be a unique way of directly measuring the single-particle spectral density. In particular, the Johnston–King results should give information about the condensate fraction n_0. (auth)

21745 EFFECT OF A SUPERFLOW ON A VORTEX LATTICE. Le Ray, M.; Bataille, J.; Francois, M.; L'Huillier, D. (Laboratoire de Mecanique des Fluides, Orsay, France). Phys. Lett.; 31A: 249-50(9 Mar 1970).

Experimental evidence is presented that the vortex lines due to rotation very probably exhibit the theoretical predicted triangular structure which persists in the presence of a superflow. (auth)

21746 FLUCTUATION CONDUCTIVITY OF A TUNNEL CONTACT AT TEMPERATURES ABOVE CRITICAL. Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). JETP Lett. (USSR) (Engl. Transl.); 10: 313-16(20 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 488-91(20 Nov 1969).

It is known that at temperatures above T_c the superconducting-ordering parameter does not vanish identically, but fluctuates with a certain small amplitude whose value increases as T_c is approached. This leads to additional conductivity of the fluctuation pairs. An analogous effect for a tunnel contact between two superconductors is considered. In the case when the voltage across the barrier does not vanish and $T > T_c$, the fluctuation conductivity of the contact oscillates as a function of time with the Josephson frequency. It follows from the results that certain features of the nonstationary Josephson effect are retained in the normal state at temperatures somewhat higher than T_c. The estimates show that, in principle, this effect can become experimentally observable. (M.H.R.)

21747 FOURTH SOUND IN FERMI–BOSE QUANTUM LIQUIDS. Sanikidze, D. G.; Shaanova, A. N. (Cybernetics Inst., Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 10: 310-12(20 Nov 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 482-5(20 Nov 1969).

The complete system of equations describing the acoustic oscillations of a Fermi–Bose liquid consists of the kinetic equation for the Fermi excitations, the continuity equation, and the equation of superfluid motion. The continuity equation for Fermi excitations and the equation of motion in a system moving with velocity $\vec{v}_s$ can be obtained from the kinetic equation by suitable integration. Here, to calculate the fourth-sound velocity, only the continuity equation for the impurities was derived from the kinetic equation and an additional condition was introduced. Using this condition a system of linearized equations describing the propagation of fourth sound in a Fermi–Bose quantum liquid was obtained. (M.H.R.)

21748 JOSEPHSON-TYPE SUPERCONDUCTIVE TUNNEL JUNCTIONS AND APPLICATIONS. Matisoo, Juri (IBM Corp., Yorktown Heights, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-5: 848-73(Dec 1969).

The physics and applications of the Josephson effect are reviewed in detail. A brief introduction to superconductivity and tunneling is provided. The configuration most fully discussed is the oxide junction. However, properties of bridges, point-contacts, and solder-blobs are also described. Among the applications reviewed are magnetometers, infrared detectors, microwave generators and mixers, voltmeters, computer logic and memory devices, relaxation oscillators, thermometers, and spectrometers. (auth)

21749 EVIDENCE FOR INTERNAL SURFACE SUPERCONDUCTIVITY IN SEVERELY DEFORMED NIOBIUM. Hill, D. C.; Kohr, J. G.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett.; 31A: 157-8(23 Feb 1970).

The disappearance of resistive critical field anisotropy at $t \approx 0.95$ for severely deformed Nb supports a model for heterogeneous nucleation of superconductivity at cell boundaries (i.e., "internal surfaces") thus explaining large discrepancies from the GLAG predictions based on bulk parameters. (auth)

21750 HEAT FLOW IN LIQUID HELIUM IN THE TRANSITION REGION. Simons, S. (Queen Mary Coll., London). Proc. Roy. Soc. (London), Ser. A; 315: 239-47(24 Feb 1970).

A theoretical treatment is given of heat flow at low temperatures in liquid helium, contained in a tube of circular cross section. Results are obtained for arbitrary ratio of phonon–phonon collision mean free path to tube radius, and agree with experiment to within a few parts per cent. (auth) (UK)

21751 REMARKS ABOUT A KINETIC COEFFICIENT FOR THE BOSE SUPERFLUID. Galasiewicz, Z. (Univ. of Wroclaw. Inst. of Low Temperatures and Structural Research, Warsaw). Bull. Acad. Pol Sci., Ser. Sci. Math. Astron. Phys., 17: 537-90 (1969).

Into the stress tensor there is formally introduced a kinetic coefficient analogous to the coefficient of viscosity. When the transverse component of the vector potential vanishes, this coefficient can be eliminated from the equations. From the non-vanishing component the coefficient remains in the equations. It is demonstrated that the coefficient is equal to zero in general. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 21626.

21752 (UCRL–50002-69) CONTROLLED THERMONUCLEAR RESEARCH. Annual Report, July 1968–June 1969. (California Univ., Livermore. Lawrence Radiation Lab.). 11 Sep 1969. 210p. Dep. CFSTI.

Separate abstracts were prepared for the 6 included sections. (M.O.W.)

For abstracts of individual sections see: 21753, 21780, and 21822–21825.

21753 (UCRL–50002-69, pp 1-28) THEORETICAL STUDIES. (California Univ., Livermore. Lawrence Radiation Lab.).

Brief outlines of research carried out during this period are given for the following areas: (1) computer simulation, (2) mirror research, (3) Astron research, (4) toroidal research, and (5) nonlinear dynamics and other studies. (M.O.W.)

Confinement and Heating

Refer also to abstract 21822.

21754 (MATT-Trans–99) TURBULENT PLASMA HEATING IN DISCHARGES WITH A SKIN CURRENT. Dubovoi, L. V.; Fedyakova, V. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Leningrad). Translated for Plasma Physics Lab., Princeton Univ., N. J., from report NP–18106. 25p. Dep. CFSTI.

An abstract of the original Russian report appeared in NSA 24: 12779.

21755 PLASMA HEATING AND COMPRESSION WHEN MOTION OF PARTICLES IS NONADIABATIC. Krivets, V. P.; Peregood, B. P. (Ioffe Physico-Technical Inst., Leningrad). Phys. Lett.; 31A: 177-8(23 Feb 1970).

The motion of charged particles in axisymmetric quickly increasing uniform magnetic fields is considered. The class of fields in which particle energy increases as ^{3}H is determined. After the field ceases its increase, all particles simultaneously reach the field axis. (auth)

21756 PROBLEM OF AMBIPOLAR DIFFUSION OF FINITE MAGNETOPLASMAS. Geissler, Klaus H. (Environmental Sci-

ence Services Administration, Boulder, Colo.). Phys. Fluids; 13: 935-40(Apr 1970).

The diffusion of weakly ionized plasmas across a magnetic field is studied by measuring their decay rates. The variation of the experimental data with magnetic field and pressure is found to be in agreement with the theory of classical diffusion. However, the absolute values of the experimental data cannot be explained in terms of ambipolar diffusion. A comparison of the data with experimental results from different authors is given. The combined experimental evidence suggested that the assumption of ambipolarity is inappropriate for the treatment of actual problems of plasma diffusion across a magnetic field. The influence of mixed boundary conditions on transverse diffusion is discussed. (auth)

21757 RADIATIVE REACTIONS IN THE RESISTIVE-DIFFUSION PROBLEM. Newcomb, William A. (Univ. of California, Livermore). Phys. Fluids; 13: 941-5(Apr 1970).

In the problem of resistive diffusion of magnetic flux lines in a one-dimensional magnetohydrodynamic system, there is an apparent indeterminacy due to insufficient boundary conditions. The indeterminacy is here resolved by the use of radiation conditions at infinity. There is an outflow of momentum from the diffusive region by radiation of magnetoacoustic waves. (auth)

21758 PLASMA MOTION INDUCED BY HIGH-INTENSITY LASER HEATING. Rehm, Ronald G. (Cornell Aeronautical Lab., Buffalo). Phys. Fluids; 13: 921-34(Apr 1970).

The macroscopic plasma response to absorption of laser radiation is examined in a one-dimensional geometry. Euler's equations with inverse bremsstrahlung energy absorption and the radiative transport equation neglecting emission and reabsorption are the governing model equations. The parameters deriving from this model are the Bouguer number, measuring the ratio of the characteristic plasma length to the absorption length at the laser frequency, and the Boltzmann number, measuring the ratio of the characteristic convective energy flux to the laser radiative energy flux. The response to incident laser radiation of an absorbing plasma slab, bounded on one side (the side from which the laser radiation impinges) by a cold, nonabsorbing gas and on the other side by a reflecting wall, is examined in detail. The initial types of plasma response are classified according to the magnitude of the Bouguer and Boltzmann numbers. For large rates of energy addition the plasma will undergo either a radiatively driven shock-wave response or a heating wave response, which is characterized by high temperatures with no induced plasma motion. An analytical solution for the heating wave and numerical solutions for each type of response are presented. (auth)

21759 ON THE CONTAINMENT OF PLASMA IN STATIONARY MAGNETIC AND HIGH-FREQUENCY FIELDS. I. Klima, R. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 20: 182-95 (1970).

The stationary state of a collisionless plasma in a magnetic mirror is analyzed provided that a strong hf field is present. The hf field frequency is somewhat higher than the electron cyclotron frequency. The pressure acting on the plasma and the height of the hf potential barrier are derived in particular. The hf potential yields the possibility of eliminating the loss cone in the velocities distribution. The upper limits, which the electron temperature must not exceed, are derived. If an appropriate stationary magnetic field is used, the required incident wave power can be diminished and the allowable electron temperature can be increased. Some new results concerning the case of a homogeneous magnetic field are presented. (auth)

21760 ON THE CONTAINMENT OF PLASMA IN STATIONARY MAGNETIC AND HIGH-FREQUENCY FIELDS. II. Klima, R. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 20: 351-5(1970).

The case is analysed when the ratio of the length of the magnetic mirror to the skin depth is arbitrary. It is shown that a certain diminishing of the required power of the incident wave can be achieved by an appropriate choice of the stationary magnetic field. The electron temperature must not be much higher than one electron volt. (auth)

21761 A PARADOX IN THE DIFFUSION OF PLASMA IN TOROIDAL MAGNETIC TRAPS. Sagdeev, R. Z.; Galeev, A. A. Dokl. Akad. Nauk SSSR; 189: 1204-7(21 Dec 1969). (In Russian).

In magnetic traps with complex geometry (Tokamak, Levitron), the generalized momentum may not be an integral of motion and, in these systems, the diffusion coefficients may show a clear dependence on the collision frequency of the same kind of particles. The kinetic equations show that, for the case of a completely ionized plasma, the diffusion current consists of two parts: an ambipolar part connected with overlapping collisions of ions and electrons and an additional diffusion connected with a change in the average longitudinal velocity. The latter term vanishes under a regime of quasi-stationary diffusion, but self-diffusion is possible during the transition intermediate period. The average ion velocity changes and there is an expansion in the ion component of the plasma. This self-diffusion ceases when the friction between the fixed and moving ions vanishes. If the ion displacement due to "self-diffusion" is found from the condition of conservation of the total generalized momentum, one arrives at the paradoxical result that the energy of the magnetic field of the current arising in the plasma exceeds the energy which is liberated because of plasma expansion. This paradox can be removed if we take into account that plasma expansion takes place under conditions where the varying magnetic field induces an electric field along the small axis of the toroid. Hence the total generalized momentum of the particles is not conserved. (TTT)

Diagnostics

Refer also to abstract 21668.

21762 (JUL-607-PP) PIEZOELECTRIC PROBE FOR MEASUREMENT OF SMALL PRESSURE PULSES IN PLASMAS. Finken, Karl Heinz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Jul 1969. 40p. (In German). Dep. CFSTI (U. S. Sales Only).

To measure small pressure changes in plasma, a piezoelectric pressure sensor associated with an amplifier was developed. The device, measuring 14 mm in diameter and 10 cm in length, was 50 times more sensitive than other equipment. Because of its smallness, the sensor could be located almost anywhere in the discharge vessel without distorting the pressure distribution. In addition to being checked with a piezoelectric shock generator, the sensor was also tested within a plasma beam of known properties. Details of the experimental design and results are represented by twenty diagrams and five tables. (tr-auth)

21763 METHOD FOR IDENTIFICATION OF ATOMIC SPECTRA BY THE DOPPLER SHIFT OF SPECTRAL LINES EMITTED BY THE PLASMA OF A COAXIAL ACCELERATOR. Dontsov, Yu. P.; Korostyleva, L. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 27: 11-14(Jul 1969).

Translated from Opt. Spektrosk.; 27: 25-30(Jul 1969).

Certain characteristics of the excitation and acceleration of ions in a coaxial plasma source are investigated. For two variants of the construction of the accelerator the distributions of spectral lines as a function of the Doppler shift are obtained. Analysis of the results shows that the proposed method enables one to carry out a fairly reliable identification of spectral lines from their membership of the spectrum of the ion of a certain degree of ionization. The presence of a structure in the spectral line distribution of one ion which in certain cases can be a source of error when determining the directional velocity of a moving plasma from the Doppler effect is considered. (auth)

21764 DETERMINATION OF ELECTRON DENSITY IN A JET OF ARGON PLASMA, WITH THE AID OF OPTICAL PYROMETER. Senski, Grzegorz (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 46, 155-64(1969). (In German).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

The measurement of the radiation intensity in the spectral continuum was used for determining the concentration of electrons, by employing the Kramers–Unsoeld equations. The measurement of the monochromatic $\lambda \cong 650$ nm temperature enabled the determination of radiation intensity from Planck's distribution of radiation density. These measurements were carried out for different currents (i = 120 to 300 A), and for different gas flows (v = 10 to 30 l/min). The results were compared with the measurements of the absolute intensity of continuum radiation (monochromator with photomultiplier, calibration with the use of a carbon arc lamp). Good agreement of the two series of measurements was noted. It was inferred that the pyrometric determination of plasma parameters for a known distribution of radiation in the continuum may be very helpful, especially when a simple and rapid measuring method is required. (auth)

21765 DETERMINATION OF PLASMA TEMPERATURE FROM THE RATIO OF $H\beta$ LINE TO SPECTRAL CONTINUUM INTENSITY. Szczepanska, Halina (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 46, 165-77 (1969). (In German).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

The possibility of determining plasma parameters from the measurements of relative intensity of $H\delta$ line to spectral continuum is analyzed. With this method, the temperature and density of electrons can be measured without the necessity of establishing the absolute intensity values and the luminous layer thickness, as is indispensable with the methods based on line intensity or continuum intensity measurements. The method enables, in addition, a verification of the method based on the Stark's broadening, as well as determination of the constant coefficient in the equation describing the intensity of the spectral continuum. The analysis was performed for argon plasma with hydrogen admixture. Preliminary results of measurements of the parameters of a ionized gas jet produced in an arc heater are quoted. (auth)

21766 MEASUREMENTS OF RATE OF PLASMA FLOW BY A FULL THRUST TUBE. Voropaev, A. A.; Dresvin, S. V.; Klubnikin, V. S. Teplofiz. Vys. Temp.; 7: 633-40(Jul-Aug 1969). (In Russian).

A method is suggested for measuring the rate of plasma flow by a full thrust tube and by a method of measuring the static pressure. A condenser microphone was used for recording pressure variations measured under stationary and nonstationary conditions. Various factors affecting the measurements of the plasma flow rate (the influence of viscosity at small Reynolds number, the pressure gradient effects on shifting the effective center of the tube, turbulence, and the rate of the transducer transmission of plasma flux) are analyzed. Radial distribution of the velocity thrust, measured in an arc with channel diameter of 20 mm at the current of 160 A, is deduced. (tr-auth)

21767 INFLUENCE OF THE TEMPERATURE OF COOLED DOUBLE PROBES ON MEASUREMENTS OF ELECTRON TEMPERATURE IN PLASMA AT ATMOSPHERIC PRESSURE. Ashin, M. I.; Vasil'eva, I. A.; Nefedov, A. P. (Inst. of High-Temperatures, Moscow). Teplofiz. Vys. Temp.; 7: 626-32(Jul-Aug 1969). (In Russian).

A double-probe method and a conversion method for sodium spectral lines were used for measuring electron temperature in the products of natural gas combustion. Variations of probe temperature from 300 to 1300°K resulted in the change of probe-determined electron temperature from 1450 to 2050°K. The probe electron current was calculated for the case of varying electron temperature inside the region of electrical perturbation. It is shown that the temperature measured by probes is determined by temperature on the external layer of electrical perturbation and by the drop of temperature inside it. (tr-auth)

21768 ALTERNATING CURRENT DIAGNOSTIC STUDY OF DIFFUSION IN A HIGHLY IONIZED PLASMA IN A MAGNETIC FIELD. Flannery, D. L.; Brown, Sanborn C. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 13: 1066-71(Apr 1970).

A new ac diagnostic technique was used to study the radial diffusion of a highly ionized hollow-cathode discharge plasma in a magnetic field. The method involves generating very low-frequency density waves in one region of the plasma and observing the diffusion of these waves through the remaining plasma. The spatial variations of phase and amplitude of the density modulation were measured with a Langmuir probe and compared with theoretical predictions corresponding to two possible diffusion mechanisms: Bohm and collisional–ambipolar. The diffusion coefficient entered as a variable parameter in each theory and was adjusted for best agreement with data in each case. Best agreement was obtained with the collisional–ambipolar theory using approximately the value of diffusion coefficient predicted for that diffusion mechanism for the plasma used. (auth)

21769 FARADAY ROTATION OF A FAR-INFRARED LASER BEAM BY A SMALL THETA-PINCH PLASMA. Turner, R.; Poehler, T. O. (Johns Hopkins Univ., Silver Spring, Md.). Phys. Fluids; 13: 1072-9(Apr 1970).

Faraday rotation measurements were made on a small theta-pinch plasma using the 337-, 128-, 119-, and 79-μm wavelength radiation of the HCN and H_2O gas lasers. Rotation angles of up to 50° were measured with an accuracy, set mainly by the laser source, estimated to be better than 10%. Enhancement or attenuation of the transmitted signal produced by density gradients in the plasma were measured simultaneously to correct the rotation measurements. The Faraday rotation measurement confirms that a magnetic probe placed in the plasma perturbs the actual field present. (auth)

21770 CHARACTERISTICS OF A SPHERICAL ELECTROSTATIC PROBE IN A BOUNDED PLASMA. Cohen, Ira M. (Univ. of Pennsylvania, Philadelphia). Phys. Fluids; 13: 889-94(Apr 1970).

Spherical electrostatic probes immersed in a slightly ionized, collision-dominated plasma bounded by a large concentric spherical electrode of radius R_w are treated by asymptotic continuum theory when the sheath thickness is small compared with the probe radius r_p but large compared with a mean free path. It is found that when R_w/r_p is large, the saturation currents are modified by only $O(r_p/R_w)$. However, the maximum slope of the characteristic increases by 20% as R_w/r_p increases from 100 to infinity. Since this slope increases similarly as the electron to ion temperature ratio τ increases, it is concluded that reduction of data for measurements in bounded plasmas using continuum theory for unbounded plasmas leads to values of τ (and usually T_-) that are smaller than the true values. (auth)

21771 EFFECTS OF ELECTRON EMISSION ON ELECTROSTATIC PROBES AT ARBITRARY PRESSURES. Chang, Kuo Wei (Space Sciences Inc., Waltham, Mass.); Bienkowski, George K. Phys. Fluids; 13: 902-20(Apr 1970).

A systematic investigation of the effects on probe response caused by electrons emitted with a half-Maxwellian distribution is performed. In the absence of collisions, a theory for spherical and cylindrical probes in a plasma of infinite extent is formulated, based on orbit calculations. A simple method is developed that greatly facilitates the solution of the space-charge-limited emission problem. The structure of the resulting double sheath is analyzed in detail. Effects of trapped particles are found to be unimportant under practical situations. Solutions of current–voltage characteristics and space-charge-limited current are presented for the case of thermionic emission. Theories in the transitional and continuum regimes for a spherical probe in a weakly ionized gas are formulated by the moment method. For a dense plasma with a free fall sheath the emission is usually both space-charge and diffusion-limited. (auth)

21772 A TIME-CORRELATED STUDY OF THE Z-PINCH DISCHARGE IN HELIUM. Dimoff, K.; Tam, S. Y. K. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 48: 884-900(1 Apr 1970).

The development of a miniature "gradient probe" and the successful superposition of multiple photographic recordings have produced useful insight into the action of the z-pinch discharge in helium. A correlation of luminosity and current fronts yields strong evidence for the occurrence of a nonionizing shock wave at high initial pressures in helium discharges. The relatively nonluminous shock front is followed by overlapping regions of He I and He II radiation within the collapsing current shell. At low filling pressures these two regions coincide and radiation is emitted from almost all the gas trapped within the current shell. In all cases the zone of maximum He II emission is observed to coincide with the position of maximum current density. Synchronization of the discharge current with time-resolved spectroscopic results indicates the presence of successive pinches. They are caused by the interaction of thermal and magnetic pressures after the first collapse of the discharge. (auth) (Canada)

21773 MEASUREMENT OF POTENTIAL VARIATIONS IN A DENSE OSCILLATING PLASMA. Zakrzewski, Z.; Beaudry, C.; Cloutier, G. G. (Univ. of Montreal). Can. J. Phys.; 48: 918-21(1 Apr 1970).

When temperature fluctuations are large in a plasma, the floating potential cannot be used to calculate electric fields. A method is described which allows the calculation of the plasma potential as a function of time from measured values of the electron temperature and the floating potential. An application of this technique to the evaluation of electric fields in a reflex discharge is briefly outlined. (auth) (Canada)

21774 PROPERTIES OF MAGNETOACTIVE PLASMA GENERATED BY HIGH MICROWAVE POWER WITH VARIABLE POLARIZATION. Musil, J.; Zacek, F. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 20: 337-40(1970).

A measurement was made of the electron density N and the transverse electron temperature $T_{e\perp}$ of a magnetoactive plasma, generated in a circular waveguide by a strong microwave signal with variable polarization. The plasma is generated in a homogeneous magnetic field parallel to the axis of the circular waveguide. The results of the measurements show the great influence of wave polarization upon the properties of the plasma. The results of the penetration of the electromagnetic wave into the plasma as a function of the wave polarization are given, too. (auth)

21775 UTILIZATION OF ROTATIONAL AND VIBRATIONAL TEMPERATURES FOR PLASMA DIAGNOSTICS OF HIGH-PRESSURE DISCHARGES. Jancz, J. (Purkyne Univ., Brno). Czech. J. Phys.; 20: 341-50(1970).

In the spectra of high-pressure discharges excited in molecular gases, very intensive molecular spectral bands may usually be observed. One may determine the rotational and vibrational temper-

atures without difficulty, however, the rotational and vibrational temperatures (T_r, T_v) do not often equal to the temperature of neutral gas (T_0) or to that of electrons (T_e). If the collision cross sections of electronic, atomic, and molecular excitation (deexcitation) are known, one may then calculate the dependence of the rotational and vibrational temperatures on T_e, T_0, N_e and the pressure of the gas. The calculations have been performed for pure N_2 and for an $Ar-N_2$ mixture at atmospheric pressure. The computed graphs make it possible to determine some of the values T_e, T_0, N_e if the temperatures T_r and T_v are known. (auth)

21776 STARK BROADENING AS A DIAGNOSTIC TOOL IN THE STUDY OF LASER-PRODUCED SPARKS. Bacon, Michael Eric. Fort Collins, Colo.; Colorado State Univ. (1969). 219p. Thesis.

Stark broadened profiles of the Lyman α, Balmer α, and Balmer γ lines are calculated. An approximate, strong collision term is included in the perturber-atom interaction. Broadening of the lower levels is considered for the Hα and Hγ lines. For Hα lower state broadening is significant and was accounted for in earlier calculations. The major contribution to the broadening results for lower state broadening of the central component. For Hγ lower state broadening is found to be insignificant. A comparison between the calculated Hα halfwidths of this report and the experimental halfwidths indicates agreement within ±5% over the density range 0.3×10^{17} to 1.5×10^{17} electrons/cm^3. Similar good agreement between the experimental and calculated halfwidths is found for the Hγ line for a range of densities 1.3×10^{16} to 4×10^{16} electrons/cm^3. However, significant deviations between the calculated and experimental widths occur at the $\frac{1}{4}$ and $\frac{3}{4}$ intensity points. A more rigorous treatment of the strong collisions and inclusion of higher order multipoles in the perturber-atom interaction are probably significant. The halfwidths of the Hα profiles calculated above are used to determine the electron density (N) in laser-produced hydrogen and argon–hydrogen plasmas as a function of time. The ratio of integrated Hα line intensity to continuum is used to determine the temperature (T) of the hydrogen plasma. The values of N and T, thus obtained, are expected to be accurate to within 20 to 30%. Experimental and theoretical collisional-radiative recombination coefficients show satisfactory agreement provided the effects of fluid motion are considered. An intensity reversal in the hydrogen plasmas is found at times of the order of 0.1 μ sec after the peak of the spark. The electron density as a function of time for an argon–hydrogen plasma is found from the experimentally measured Hα halfwidths. An estimate of the temperature is found from the recombination coefficient. (Diss. Abstr.)

Kinetics (General)

Refer also to abstracts 20743 and 21753.

21777 THE PERMITTIVITY OF A PLASMA AT CYCLOTRON RESONANCE IN LARGE-AMPLITUDE EM FIELDS. Schram, D. C. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Physica; 46: 97-118(23 Feb 1970).

The permittivity of a collisionless plasma as a function of field parameters is measured in standing and in traveling waves. In both experiments the permittivity remains finite at cyclotron resonance; the resonance is broadened and shifted towards higher values of the magnetic field strength. The results are in quantitative agreement with theoretical predictions which follow from a cold-plasma, large-signal analysis. The loss tangent of the plasma is measured. The loss is found to be due to the escape of accelerated particles. (auth)

21778 DETECTION OF AN ELECTROMAGNETIC WAVE BY A PLASMA. Bloyet, Jean (Paris Univ., Orsay, France); Talsky Antonin. Compt. Rend., Ser. B; 270: 448-51(16 Feb 1970). (In French).

The variation of the characteristic curve of a luminescent discharge when the negative flow is influenced by an electromagnetic wave is studied with the intention of realizing a hyperfrequency wave detector. The first results obtained gave a sensitivity of 2 V/mW and a tangential sensitivity of 4,7 dBm. (France)

Kinetics (Experimental)

21779 (JPRS-50157) FREE PLASMA COLUMN IN A HIGH FREQUENCY FIELD AT HIGH PRESSURE. Kapitsa, P. L. Translated from Zh. Eksp. Teor. Fiz.; 57: 1801-66(1969). 87p. CFSTI.

An abstract of the original Russian article appears as NSA 24: 12802.

21780 (UCRL-50002-69, pp 151-67) PLASMA AND ATOMIC RESEARCH. (California Univ., Livermore. Lawrence Radiation Lab.).

Summaries of research on the following areas are given: (1) experiment with laser-produced plasma, (2) light scattering by a sheet pinch, (3) spectroscopic studies, (4) "cold" microwave–plasma experiment, (5) partially ionized plasmas, and (6) atomic cross sections. (M.O.W.)

21781 FORMATION AND CHARACTERISTICS OF MOLECULAR CESIUM IONS IN CESIUM DISCHARGE PLASMA. Morgulis, N. D.; Korchevoi, Yu. P.; Dudko, D. Ya. Ukr. Fiz. Zh.; 14: 2083-6(Dec 1969). (In Russian).

Formation of an unexpectedly high amount of molecular cesium plasma was previously discovered in studies of low-voltage cesium arc discharges, and it was suggested that the formation of these ions was related to the conversion process. Further studies were made and data obtained for the cases of long-discharge plasma and short-discharge plasma diodes. Graphs of the first instance show that the number of molecular ions of cesium may reach considerable magnitude and then start reducing with the rise of n_e and increasing with the increase of cesium atom concentration. Analysis of the results showed that the formation of molecular ions must follow the mechanisms of ion conversion ($Cs^+ + 2\,Cs \rightarrow Cs_2^+ + Cs$ or $Cs^+ + Cs + e \rightarrow Cs_2^+ + e$) and does not have direct relation to the nature of primary ionization in an ordinary long cesium discharge plasma. (tr-auth)

21782 SOME PECULIARITIES OF CESIUM LEVELS AT DECAY OF DISCHARGE CESIUM PLASMA. Morgulis, N. D.; Polushkin, I. N.; Kravchenko, A. I. (Kiev State Univ. Kiev Inst of Electrodynamics). Ukr. Fiz. Zh.; 14: 2080-3(Dec 1969). (In Russian).

Certain peculiarities in cesium level population during decay of a discharge cesium plasma were analyzed. The postulation made by N. D. Morgulis et al. (Ukr. Fiz. Zh., 14: 507(1969)) on the possibility of obtaining inverse population of cesium levels during the decay was confirmed. (R.V.J.)

21783 INVESTIGATIONS OF THE STRIATED PLASMA FLOW. Milewski, Jerzy; Stanco, Jerzy; Samulski, Jan (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 46, 139-46(1969).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

Argon was preheated to about 600°K and mixed with potassium vapors. The experiments were performed at pressures of 15 to 40 mm Hg, seed concentrations of 0.2 to 0.3%, flow velocities of 70 to 100 n/sec, igniting pulse repetition rates of 400 to 1000 Hz, and duct electric field frequency of about 8 kHz. Striated flow was obtained for electric field amplitude E greater than 1.6 to 2.15 V/cm, depending on the pressure. Measurements are described. (M.O.W.)

21784 CONTINUOUS RADIATION OF LOW-TEMPERATURE ARGON PLASMA. Batenin, V. M.; Minaev, P. V. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp.; 7: 604-9(Jul-Aug 1969). (In Russian).

Continuous radiation intensities from argon plasma at 12,000 to 16,000°K were measured in the frequency interval of 0.13×10^{15} sec$^{-1} \leq \nu \leq 1.2 \times 10^{15}$ sec^{-1}. Data obtained were compared with calculated results. Measurements were also made of the reduced potential of atom ionization in plasma as a function of the temperature. Experimental data were correlated with the calculated data on the basis of Inglis–Teller theory. (tr-auth)

21785 INFLUENCE OF TRANSVERSE MAGNETIC FIELDS ON THERMAL FLOW TOWARDS ELECTRODES IN HIGH-CURRENT DISCHARGES. Konovalov, A. E. (Central Research Inst. of Aviation Engineering, Moscow). Teplofiz. Vys. Temp.; 7: 615-19(Jul-Aug 1969). (In Russian).

Measurements were made of thermal flow towards point electrodes in crossed E–H fields. The magnetic field intensity reached 10 kOe and the current 10 kA. The method of measurement was described in earlier work (Teplofiz. Vys. Temp., 7: No. 1(1969)). An extensive derivation of results is presented. (tr-auth)

21786 COLLISIONLESS SHEATH: AN EXPERIMENTAL INVESTIGATION. Goldan, Paul D. (Environmental Sciences Services Administration, Boulder, Colo.). Phys. Fluids; 13: 1055-9(Apr 1970).

An electron beam probing technique was utilized to measure the sheath electric field distribution near a planar floating plate immersed in a low-pressure argon arc discharge plasma. The static sheath field determined by this nonperturbing measurement is compared with the predictions of the collisionless or free-fall model of the sheath. The agreement is found to be so

satisfactory that such static sheath field measurements, supplemented by floating potential measurement, are sufficient to yield accurate values of the plasma electron density and temperature. (auth)

21787 RECOMBINATION OF RARE GAS IONS WITH ELECTRONS. Oskam, H. J. (Univ. of Minnesota, Minneapolis). pp 463-523 of Case Studies In Atomic Collision Physics. I. /McDaniel, E. W. (ed.). New York; John Wiley and Sons, Inc. (1969).

Features of the two processes most actively involved in electron–ion recombination in rare gas plasmas, dissociative recombination and collisional–radiative recombination, are reviewed. Experimental methods are described: the microwave-cavity method, light spectrometer techniques, and mass spectrometer techniques. A summary of data leads to the conclusion that the process involved in decaying helium plasmas is probably a collisional process, while that involved in other rare gas plasmas is dissociative recombination of molecular ions. 72 references. (A.G.W.)

21788 ACOUSTIC PERTURBATIONS IN A PULSED RF PLASMA. Waidmann, G. (Kernforschungsanlage, Juelich, Ger.). Z. Phys.; 233: 351-7(1970).

The response of a stationary weakly ionized plasma to a density perturbation in the neutral gas component was studied in a neon plasma with the following typical properties: electron density $N_e \approx 8 \times 10^{12}$ cm^{-3}, electron temperature of the axis of the vessel $T_{e0} \approx 3.0$ eV; neutral gas density $N_n \approx 1 \times 10^{17}$ cm^{-3} and neutral gas temperature $T_{n0} \approx 600$°K. A neutral density perturbation, generated 50 cm apart from the plasma, produces a fluctuation in the ion density and a sharp spike in the differential voltage of a floating double probe. The experimental observations demonstrate the propagation of an ion sheath and of an electric field perturbation together with the neutral density perturbation. An interpretation of the plasma response to acoustic-wave pulses has been proposed by Ingard and Schulz in a theory on acoustic wave modes in a weakly ionized gas. The experimental results are in good agreement with the theoretical expectations. (auth)

21789 VARIATION WITH TEMPERATURE OF THE HALF-WIDTH AND SHIFT OF THE 4300-A EMISSION LINE OF AN ARGON PLASMA AT ATMOSPHERIC PRESSURE. Queffelec, Jean-Louis; Girault, Michel (Rennes Univ., France). Compt. Rend., Ser. B; 270: 471-3(16 Feb 1970). (In French).

A photoelectric spectroscopy apparatus is described that allows several profiles of one emission line of an argon–hydrogen plasma of cylindrical symmetry to be recorded during a single rotation of the spectrograph grating. The Abel transformation is directly applied to the recorded profiles. The temperature radial distribution is determined through the method of Stark broadening of the Hβ line of hydrogen, and the half-width and position of the 4300-Å line of Ar I are measured at different distances from the plasma axis. These measurements, near the axis, are in good agreement with the values calculated from Griem theoretical data. (France)

21790 INTERPRETATION OF CURRENT–VOLTAGE CHARACTERISTICS IN PLASMAS. George, D. W. (Univ. of Sydney); Messerle, H. K. Elec. Eng. Trans., Inst. Eng., Aust.; EE5: 329-37([1970]).

A classification of the different possible conduction modes is attempted for the prebreakdown region in which no additional ionization is produced by primary or secondary collision processes. It is shown that diagnostic use of the characteristic can often be made to determine parameters such as the ionization rate, the density and temperature of the ion population in the plasma, the surface work function, or the plasma conductivity. (Australia)

Kinetics (Theoretical)

Refer also to abstract 21906.

21791 WEAKLY IONIZED FIELD-FREE PLASMAS ENCLOSED IN EMITTING SURFACES. Ekbote, D. D.; Schott, L.; Whitfield, D. W. A. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys.; 48: 775-83(15 Mar 1970).

Calculations are presented for the spatial charge-density distribution in a stationary, weakly ionized, low-pressure plasma which is enclosed in plasma-emitting surfaces. Solutions are given for the cases that the emitting boundaries are two infinite parallel planes, an infinite cylinder, a sphere, and a cylinder of finite length with absorbing end faces. The theoretical results for the finite cylinder are compared with experimental data on helium, argon, and nitrogen at pressures between 0.1 and 0.5 torr using a new plasma source. The plasma is produced by a discharge in a region between two concentric cylinders; the inner one, the anode, is perforated and a quiescent diffusion plasma free of electric fields and electric currents is formed in its interior with densities between 10^8 and 10^{11} cm^{-3} and electron temperatures of 0.3 to 0.5 eV. Qualitative agreement between the observed and calculated density distributions was found in certain cases. (auth)

21792 RADIATION ENERGY LOSSES FROM DENSE XENON PLASMA. Andreev, S. I.; Gavrilov, V. E. Teplofiz. Vys. Temp.; 8: 203-5(1970). (In Russian).

Integral radiation losses in a dense xenon plasma were measured using a pulsed discharge in a closed quartz tube filled with xenon with initial pressure from 50 to 600 mm Hg with inside diameter from 4 to 15 mm and 150 mm distance between electrodes. Plasma temperature as a function of initial intensity of discharge was determined. Curves of electrical and optical magnitude variations during the discharge are given. It was found that in sufficiently dense plasma ($p \geq 10$ atm and $T = 10{,}000$ to $20{,}000$°K) the magnitude of energy losses per unit cylinder surface varied very little from one another. Plasma pressure was estimated using calculations of equilibrium ionized plasma composition at given temperature, initial gas pressure, and radial temperature distribution. Tabulated data on relative radiation losses in plasma cylinders were used for estimating plasma temperature. (R.V.J.)

21793 PARAMETERS OF HYDROGEN PLASMA IN SUPERSONIC SPHERICAL SOURCE. Gol'dfarb, V. M.; Kostygova, I. E.; Luk'yanov, G. A. (Central Research Inst. of Aviation Engineering, Moscow). Teplofiz. Vys. Temp.; 7: 610-14(Jul-Aug 1969). (In Russian).

Numerical integration of a system of equations for a stationary source of nonequilibrium hydrogen plasma was obtained. Collisional-radiational recombination was considered as the determining elementary process. In order to determine the influence of reabsorption, calculations were made for optically thin and optically thick plasma for all types of emissions, and also for optically thick plasma the case of resonance emissions. A strong disturbance of thermal and ionization equilibrium was observed in the flow region. Reabsorption of radiation results in a strong break in electron temperature from the temperature of heavy particles and in reduced rate of recombinations. The population of hydrogen levels was determined in quasi-stationary approximation, using the previously obtained concentration values. Radiation intensification coefficients were calculated for a series of transitions. (tr-auth)

21794 TRANSPORT PROCESSES IN TWO-COMPONENT PLASMA ON THE BASIS OF THE LANDAU EQUATION. Saraf, J. R. (Indian Inst. of Science, Bangalore). J. Indian Inst. Sci.; 51: 367-76(Oct 1969).

Transport processes in a fully ionized plasma, governed by the kinetic equation proposed by Landau, are investigated by expanding the distribution functions of ions and electrons in terms of generalized Hermite polynomials, following Grad. From the resulting transport equations, expressions for viscosity, thermal conductivity, diffusivity, electric conductivity, and Townsend coefficients in the presence of a constant, uniform, strong magnetic field, are deduced. These expressions have similar forms to those obtained earlier by the same procedure by Devanathan, Raghavachar and Ram Babu on the basis of the Fokker–Planck equation. This is as expected since the Landau equation, in principle, is another version of the Fokker–Planck equation, taking into account small simultaneous particle interactions. Using the expression for electric conductivity, the decay length of disturbances in the stellar photosphere, like regions of turbulence, is calculated and is found to increase both with the decrease in number density and increasing temperature, thereby providing an efficient mechanism for coronal heating. Further, the ratio of thermal conductivity to electric conductivity has linear dependence on temperature in agreement with the Wiedemann–Franz law, although the slopes in the two cases are different. The other transport coefficients show the same behavior as in earlier investigations. (auth)

21795 CYCLOTRON HARMONIC EMISSION BY MODE CONVERSION IN A NONUNIFORM PLASMA SLAB. Alper, A. T. (Bell Telephone Labs., Inc., Holmdel, N. J.); Gruber, S. Phys. Fluids; 13: 1089-1100(Apr 1970).

Electromagnetic emission from a warm collisionless nonuniform plasma slab is considered for frequencies of observation near the second electron cyclotron harmonic. The model for the emission mechanism is that fast electrons in the dense plasma core generate electrostatic waves which are then trapped in the high-density region between the upper hybrid resonance points where the electrostatic waves drive the extraordinary wave that propagates out of the plasma. The energy lost by the fast particles to longitudinal waves is evaluated by retaining collisionless damping using a dressed test-particle approach. The elec-

tromagnetic radiation field is calculated using an equation which includes coupling between the longitudinal and transverse fields in the density region encompassing the upper hybrid frequency [$\omega_c^2(x) = \omega^2 - \omega_c^2$]. The calculation shows that the emission spectrum contains a fine structure and that as much as 90% of the longitudinal wave energy is converted into electromagnetic wave energy. (auth)

21796 THERMAL AND ELECTROMAGNETIC FORCES INDUCED BY THE INTERACTION OF LASER RADIATION WITH A PLASMA. Steinhauer, Loren C.; Ahlstrom, Harlow G. (Univ. of Washington, Seattle). Phys. Fluids; 13: 1103-5(Apr 1970).

The interaction of laser radiation with a hot nonuniform plasma is examined. Two types of forces, thermal and electromagnetic, are shown to be important. The magnitudes of these forces are determined for the interesting ranges of temperature and density. (auth)

21797 PLASMA SHIELDING. Friedman, Herbert W. Levi, Enrico (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Phys. Fluids; 13: 1049-54(Apr 1970).

Necessary and sufficient conditions are established for the shielding of current-carrying plasmas by means of space-charge sheaths. These conditions reduce to Bohm's shielding criterion in the particular case of zero current and, in general, are consistent with measurements obtained by means of Langmuir probes and their current interpretation. (auth)

21798 NONMAXWELLIAN EQUILIBRIUM DISTRIBUTION FOR FREE ELECTRONS IN A PLASMA. Wright, T. P. (Sandia Labs., Albuquerque, N. Mex.); Theimer, O. H. Phys. Fluids; 13: 895-901(Apr 1970).

A free (bound) electron in a plasma is defined by requiring that its total energy ϵ be larger (smaller) than some negative value E^*, which may be thought of as the energy $E(\nu^*)$ of an electron in a Bohr orbit with principal quantum number ν^*. This separation of bound and free states is explicitly incorporated into the electron partition function. The free electrons can then be treated by classical statistics without encountering the familiar Coulomb divergence. It is found that an electron moving in the potential well of a nearest neighbor ion has a non-Maxwellian kinetic energy distribution given by $f(w) = (\beta/a)(\beta w)^{\frac{1}{4}}\, G(\beta w) \exp(-\beta w)$, with $w = \frac{1}{2} mv^2$, $\beta = (kT)^{-1}$, and a is a normalization constant. The non-Maxwellian term clearly resides in $G(\kappa) = \int_{t_0}^{\kappa+t_0} \exp(t)(dt/t^4)$, where $\kappa = \beta w$, $t_0 = \beta e^2/r_0$, r_0 is the average interparticle distance, and e is the magnitude of the electronic charge. $G(\kappa)$ can be expressed in terms of tabulated functions. The average kinetic energy of an electron with a nearest-neighbor ion has a dominant correction term proportional to the Debye–Hückel energy e^2/D, where D is the Debye length, in agreement with previously published results. The consequences of this distribution function on the Einstein relation and Wiedemann–Franz law are investigated. (auth)

21799 TEMPERATURE EFFECTS ON HIGH-FREQUENCY BEAM PLASMA INTERACTION. Seidl, M. (Stanford Univ., Calif.). Phys. Fluids; 13: 966-79(Apr 1970).

The dispersion equation corresponding to the interaction of an electron beam with a Maxwellian plasma has been solved in quasistatic and infinite geometry approximations. Two representative beams are considered: a parallel beam with isotropic velocity spread and a helical beam with different longitudinal and transverse temperatures. The aim of the work is to predict the frequency, growth rate, and wavenumbers of the most unstable waves as functions of the basic beam and the plasma parameters. The results of the calculations are presented in graphs suitable for comparison with the experiments. The effect of plasma and beam temperatures on the spectrum of the instabilities is discussed in detail. It is shown that the plasma temperature reduces the growth rate of the instabilities at cyclotron harmonic frequencies while a velocity spread in the helical beam suppresses the instabilities everywhere, except in the vicinity of the cyclotron harmonics. (auth)

21800 PHASE SPACE HYDRODYNAMICS OF EQUIVALENT NONLINEAR SYSTEMS: EXPERIMENTAL AND COMPUTATIONAL OBSERVATIONS. Berk, H. L. (Univ. of California, Livermore); Nielsen, C. E.; Roberts, K. V. Phys. Fluids; 13: 980-95(Apr 1970).

The one-dimensional Vlasov equation describes the behavior of an incompressible self-interacting classical fluid that moves in the (q,p) phase plane. This type of phase fluid occurs in many physical problems and its hydrodynamic properties can be examined from a general point of view. A characteristic feature with initially unstable spatially homogeneous configurations is the development of stable nonlinear phase structures. Such examples occur as the result of the gravitational Jeans instability, or the two-stream and negative-mass instabilities of charged-particle beams. These structures can be related to one another by extending a duality principle due to Dory. The stable cavities in phase space which have been observed in numerical calculations on the two-stream instability are compared with stable proton clusters which develop from the negative-mass instability in the mirror experiment DCX-1. (auth)

21801 NONLINEAR EVOLUTION OF COLLISIONLESS ELECTRON BEAM–PLASMA SYSTEMS. Thompson, James Robert. Austin, Tex., Univ. of Texas (1969). 121p.

Thesis.

A theoretical investigation of the nonlinear time evolution of collisionless electron beam–plasma systems was undertaken. An initially cold plasma state was assumed, and hence the theory of weak turbulence was not applicable. In order to achieve some degree of mathematical tractability for the nonlinear equations, the generality of the problem was reduced by several assumptions—principally the restriction of one-dimensional electrostatic oscillations and the introduction of the ratio of the two beam populations as a small parameter. The linear theory was reviewed and a theory of the nonlinear saturation and subsequent dynamical evolution of the system was developed. It is shown that the electrostatic field undergoes rapid growth to a state of meta-equilibrium, followed by a slower time development. The mechanism for the nonlinear stabilization of this growth is the trapping of beam electrons in the wave troughs of the electrostatic field. The existence of a single wave nonlinear Bernstein–Greene–Kruskal stationary state was established, and its properties (e.g., its energy content) were evaluated. It was discovered that due to nonlinear interactions, this stationary wave had been somewhat slowed. The problem of the stability of this stationary state was formally posed, but not solved. The predictions of the theories were compared with computer calculations, and were found in good agreement. A brief examination of the linear theory of finite sized beams is also included. (Diss. Abstr.)

21802 STUDY OF THE IONIZATION RATE VARIATIONS IN IONIZATION WAVES IN PLASMA. I. Sicha, M.; Rezacova, V. (Charles Univ., Prague). Czech. J. Phys.; 20: 356-61(1970).

The value of the phase of the maximum of ionization rate variations is calculated by using the relations determined in the present paper and the experimental results obtained by Šicha and Drouet (Can. J. Phys., 46: 2491(1968)). A possible interpretation of the results obtained is proposed, taking into account the variation of the electron energy distribution function. (auth)

21803 NONCOLLECTIVE MOTION OF ELECTRONS AND IONS IN AN ELECTRIC FIELD. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Int. J. Electron.; 28: 229-36(Mar 1970).

The noncollective diffusion and field drift of electrons and ions are analyzed for a partially ionized gas slab containing a volume ionization source. The boundaries are formed by plane electrodes through which a strong electric field is applied. This system is described by the nonlinear diffusion-drift equations for the charged particle components, and the Poisson equation for the space charge field. A simultaneous solution of these equations is given by the method of successive approximations. Thus, analytical formulae are derived for: (1) the electron and ion distributions across the gap; (2) the electric field distribution including the anode and cathode space charge regions; and (3) the characteristics of the current–voltage relation (saturation effect). (auth) (UK)

21804 INTRINSIC QUANTUM BEHAVIOR OF THE FULLY IONIZED GAS. Grandy, W. T. Jr. (Univ. of Wyoming, Laramie). Nuovo Cim., B; 65: 73-99(11 Jan 1970).

The higher-order contributions beyond the so-called ring diagrams are studied in considerable detail in order to determine the intrinsic quantum-mechanical behavior of a nonrelativistic fully ionized gas at high temperature and low density. Previous calculations of the equation of state of this system are analyzed at length and the causes for the differences in the various results are isolated. It is demonstrated that the fully ionized gas is indeed without a classical limit, and that the quantum singularities are entirely logarithmic in character. An important aspect of the present work is the summation of quantum-mechanical double bond, or ladder diagrams corresponding to exchange interactions; the latter are always significant in analyzing the quantum properties of electromagnetic many-body systems. (auth)

21805 RADIATION FROM A MAGNETIC LINE SOURCE IN A MOVING ISOTROPIC PLASMA. Kojima, T.; Itakura, K. (Osaka Univ.). Can. J. Phys.; 48: 873-8(1 Apr 1970).

The problem of radiation from an electric dipole placed in a moving isotropic plasma was studied by Lee and Papas for a spe-

cial case where the velocity of the plasma is relatively small compared with the light velocity in vacuum. A radiation problem is considered for a more general case where no restriction is imposed on the magnitude of the velocity of the plasma, and for a case where the source of radiation is assumed to be a magnetic line source. The effects of the movement of the plasma on the far-zone radiated electromagnetic fields and on the radiation pattern are studied. The results show that the Poynting vector has a circumferential component, and therefore the direction of radiated-energy flow deviates from the radial direction, and it depends on the magnitude of the velocity of the plasma and on the angle between the position vector of an observer and the velocity vector of the plasma. Some numerical examples of its deviation and of the radiation pattern are illustrated. (auth) (Canada)

21806 I. THERMODYNAMIC AND KINETIC BEHAVIOR OF AN ARGON PLASMA JET. II. DECOMPOSITION OF NITRIC OXIDE BETWEEN 1300 AND 1750°K IN AN ARGON PLASMA. Desai, Satish Vithal. Pasadena, Calif.; California Inst. of Tech. (1969). 230p.

Thesis.

In the first part of the study, an rf-coupled, atmospheric-pressure, laminar plasma jet of argon was investigated for thermodynamic equilibrium and some rate processes. Improved values of transition probabilities for 17 lines of argon I were developed from known values for 7 lines. The effect of inhomogeneity of the source was pointed out. The temperatures, T, and the electron densities, n_e, were determined spectroscopially from the population densities of the higher excited states assuming the Saha–Boltzmann relationship to be valid for these states. The axial velocities, v_z, were measured by tracing the paths of particles of boron nitride using a three-dimensional mapping technique. In the second part of the study, decomposition of NO was studied in the plasma at lower temperatures. The mole fractions of NO denoted by x_{NO} were determined gas-chromatographically and varied between $0.0012 < x_{NO} < 0.0055$. The temperatures were measured pyrometrically and varied between $1300 < T < 1750°K$. The observed rates of decomposition were orders of magnitude greater than those obtained by the previous workers under purely thermal reaction conditions. The overall activation energy was about 9 kcal/g mol which was considerably lower than the value under thermal conditions. The effect of excess nitrogen was to reduce the rate of decomposition of NO and to increase the order of the reaction with respect to NO from 1.33 to 1.85. The observed rates were consistent with a chain mechanism in which atomic nitrogen and oxygen act as chain carriers. The increased rates of decomposition and the reduced activation energy in the presence of the plasma could be explained on the basis of the observed large amount of atomic nitrogen which was probably formed as the result of reactions between excited atoms and ions of argon and the molecular nitrogen. (TSS) (Diss. Abstr.)

21807 A LINEAR-RESPONSE ANALYSIS OF ELECTROMAGNETIC RADIATION EMANATING FROM A PLASMA. Starr, Stuart Howard. Urbana, Ill.; Univ. of Illinois (1969). 178p.

Thesis.

A many-body analysis is made to determine the radiation (due to current fluctuations) that emanates from a high-density, low-temperature "quantum" plasma, and in the classical limit, for a low-density, high-temperature "classical" plasma. Radiation due to field fluctuations that are independent of current fluctuations is not considered in this paper. The model is a stationary, homogeneous (possibly anisotropic) system, manifesting periodic boundary conditions, in which a quantum plasma interacts with a classical electromagnetic field. In order to ensure a minimally redundant analysis, a careful gauge analysis is initially undertaken. The system is described by noting its response to both a bare current probe (the "true" response) and to a "dressed" current probe (the "screened" response). These response functions are tensors in which longitudinal and transverse effects are treated on an equal basis. The ease of formulation and range of validity of the respective descriptions are contrasted. These results are related to the field and current correlation tensors in a system at thermodynamic equilibrium by invoking the fluctuation–dissipation theorem. The relationship is then extended to stationary, multicomponent systems (where the components may be characterized by different temperatures) and interpreted as a superposition theorem. This allows one to find any parameter correlation tensor, once the system's single particle distribution function and a linear response function (either true or screened) is known. Within the region of mutual validity, this superposition principle is shown to agree with a comparable theorem derived by Rostoker, Eldridge and Aamodt from a BBGKY argument. Finally, the power spectrum that an experimenter would observe is related to the current–current correlation tensor. As an application of the theory, the radiation arising from current fluctuations is explored for two cases: a classical, isotropic plasma and a classical, warm beam-plasma. In the latter case, coupling between the transverse and longitudinal modes occurs, providing greatly enhanced radiation at the onset of a quasi-longitudinal instability. This suggests the possibility of monitoring critical longitudinal fluctuations in an anisotropic system by examining the emitted radiation spectrum. (Diss. Abstr.)

21808 TRANSPORT PROPERTIES OF PARTIALLY IONIZED NONEQUILIBRIUM GASES. Grohs, Gerhard Ludwig. Ithaca, N. Y.; Cornell Univ. (1969). 309p.

Thesis.

A derivation is presented of conservative equations and transport coefficients for partially ionized gases. Its aim is to provide a consistent basis for experimental and analytical studies of nonequilibrium transport phenomena in such gases in the presence of electric and magnetic fields. The range covered here is that of weakly to fully ionized plasmas with finite departures from thermal and chemical equilibrium. Although the final formulation is in terms of monatomic gases, the approach can be extended to polyatomic gas mixtures. (TSS) (Diss. Abstr.)

21809 DERIVATION OF PLASMA KINETIC THEORY FROM THE RANDOM FLUCTUATION SPECTRUM. Hicks, Walter Joseph. University Park, N. Mex.; New Mexico State Univ. (1969). 171p.

Thesis.

Light scattering by an ionized plasma is studied in detail with particular emphasis on collisions, relativistic effects and general relationships to plasma kinetic theory. It is shown that, for a nonrelativistic plasma under conditions of thermal equilibrium, many collective aspects of a plasma may be derived from the incoherent light scattering spectrum without the need of a kinetic equation. (TSS) (Diss. Abstr.)

Production

Refer also to abstract 21774.

21810 MULTIPLY CHARGED HEAVY IONS PRODUCED BY ENERGETIC PLASMAS. Postma, H. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 31A: 196-7(23 Feb 1970).

Intense multiply charged heavy ion beams may be produced through single-impact ionization with subsequent shakeoff of electrons when heavy elements are introduced into presently available mirror-contained energetic electron plasmas. Uniform steady-state currents of 6 mA of Xe^{12+} over a 300 cm^2 area appear likely. (auth)

21811 EFFECT OF HYDROGEN ADMIXTURE ON THE CHARACTERISTICS OF ARC HEATER, AND ON PLASMA JET PARAMETERS. Smigielski, Jozef (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 46, 61-78 (1969). (In German).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

A theoretical analysis and the results of experiments on the flow of an argon–hydrogen mixture in electric discharges are given. Relations of gas enthalpy and electron density for the argon–hydrogen mixture are derived, and the method of determining mean values of parameters corresponding to the assumption of one-dimensional flow is given. General relations, taking account of the nonuniformities in parameter distribution, are also given. The experiments were carried out in an arc heater, and aimed, in the first place, at establishing the effect of hydrogen admixture on the heater characteristics. Variations of gas flow, current, and the type of gas inlet (tangential or axial) were also examined. The heater operation was characterized by the following parameters: voltage drop, heat removal by cooling water (efficiency), mean terminal temperature and electron density, and magnitude and form of voltage fluctuations. The hydrogen admixture increases the voltage drop and the fluctuations (for a given flow of gas and current). The admixture has no influence on maximum electron density and temperature and a negligible influence on mean values of these parameters. (auth)

Stability

Refer also to abstracts 21753, 21831, and 21832.

21812 INSTABILITY IN A RADIO-FREQUENCY DISCHARGE IN ARGON IN THE PRESENCE OF A MAGNETIC FIELD. Brooks, D.; Pepin, H. (Univ., Montreal). Can. J. Phys.; 48: 784-92 (15 Mar 1970).

Some experimental results and their theoretical interpretation

are presented on the plasma instabilities found in a radio-frequency discharge in argon in a magnetic field. The cylindrical plasma vessel has a conducting wall and a length-to-diameter ratio of less than one. No narrow-band sinusoidal oscillations are obtained except for within the approximate pressure range 0.1 to 1 torr, where a low-frequency, high-mode-number oscillation is found. This latter is tentatively accounted for using hydrodynamic theory. (auth)

21813 DRIFT MODE FREE PLASMAS. Kadish, Abraham (New York Univ., N. Y.). Phys. Fluids; 13: 1007-8(Apr 1970).

It is shown that drift modes of other theories cannot be accounted for by a linear analysis of the kinetic guiding-center plasma model. (auth)

21814 EFFECTS OF COLLISIONS ON SPATIAL PLASMA WAVE ECHOES. Ichikawa, Yoshi H.; Suzuki, Takehiko (Nihon Univ., Tokyo). Phys. Fluids; 13: 1115-17(Apr 1970).

Collisional effects of spatial plasma wave echoes are studied for an electron plasma on the basis of simple collision models. It is shown that the central structure of the spatial wave echo may be determined by the saddle-point contribution of the free-streaming plasma particles. (auth)

21815 INSTABILITY OF THE m = 1 MODE OF A ROTATING θ PINCH. Freidberg, J. P.; Wesson, J. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 13: 1117-18(Apr 1970).

It is shown that, in contrast to previously published results, the m = 1 mode of a rotating θ pinch is magnetohydrodynamically unstable. (auth)

21816 QUASILINEAR STABILIZATION OF THE TRANSVERSE INSTABILITY. Albright, Norman W. (Univ. of California, Berkeley). Phys. Fluids; 13: 1021-30(Apr 1970).

The transverse instability is studied for the case of an infinite unmagnetized plasma with small electron temperature anisotropy. Growth rates and normal modes are found. Relativistic corrections to the growth rate have a stabilizing effect. The distribution function satisfies a diffusion equation with an additional flow term. The diffusion term causes the anisotropy to disappear and thus stabilizes the instability. The flow term is a perfect time derivative and makes no contribution to the net change in the distribution function between initial and final states which have negligible wave spectra. (auth)

21817 DYNAMIC STABILIZATION OF THE m = 1 INSTABILITY IN A BUMPY THETA PINCH. Berge, G. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids; 13: 1031-42(Apr 1970).

Both theoretically and experimentally a bumpy theta pinch is known to be hydromagnetically unstable. The possibility of dynamic stabilization of this configuration is discussed. The results show that stability can be achieved in this way. The plasma column is assumed to be separated from a vacuum magnetic field by a sharp boundary. The analysis is based on a generalization of the hydromagnetic energy principle. Within the framework of this theory a sufficient condition for stability is obtained for the m = 1 mode. This condition contains the amplitude of the unstable bulge, the frequency and amplitude of the forced oscillations, and the characteristic lengths and speeds in the system. The condition shows that stability is obtained for sufficiently large amplitude in the oscillatory magnetic field. The case of $\beta = 1$ and "arbitrary" m numbers is also briefly reviewed. (auth)

21818 FEEDBACK STABILIZATION OF A CONFINED PLASMA. Samain, Andre (CEN, Fontenay-aux-Roses, France). Compt. Rend., Ser. B; 270: 452-5(16 Feb 1970). (In French).

It is shown that all electrostatic modes of a confined plasma can be stabilized if particle sources associated with the electron density variations are properly subdued. The possibility of negating such sources with the help of a high-frequency field injected into the plasma is also investigated. (TSS) (France)

21819 COLLISIONAL DRIFT INSTABILITY OF A CURRENTLESS WEAKLY IONIZED MAGNETOPLASMA. Mumola, Peter Benedict. Austin, Tex.; Univ. of Texas (1969). 80p. Thesis.

The results of a theoretical and experimental study of the stability of inhomogeneous weakly ionized magnetoplasmas with no axial drift are reported. A linearized two-fluid hydrodynamic stability analysis yields a dispersion relation which is analyzed numerically. Oscillations with an azimuthal phase velocity approximately equal in magnitude and in the same direction as the electron diamagnetic drift are predicted to become unstable (onset) once the external magnetic field exceeds some critical value. This instability has been observed experimentally in a capacitively coupled rf discharge immersed in a static, uniform magnetic field. The rf discharge was utilized in order to simulate a plasma with no applied axial drift of particles. Stability criteria are displayed graphically in terms of the magnetic field strength, neutral gas pressure, and discharge tube radius. Experimental measurements are found to be in excellent agreement with the predicted values of critical magnetic and phase velocity over a wide range of neutral gas pressures and several different discharge tube radii. Furthermore, the results also explain similar phenomena observed in a number of other experiments involving weakly ionized magnetoplasmas which, up until this time, were not accounted for. (Diss. Abstr.)

21820 STATIONARY STATE OF HIGH-β COLLISIONLESS PLASMA. Kurasawa, Takasi (Electrotechnical Lab., Tokyo). Kakuyugo Kenkyu; 24: 185-200(Jan 1970). (In Japanese).

The stationary state of a linear θ pinch plasma with an axial current is discussed. The assumptions that the plasma is collisionless, axially symmetric, uniform in the axial direction and neutral, are used in the derivation of the equations that describe the stationary state. The several results of the numerical analysis for the equations are given. Furthermore, in order to compare the stationary state with an axial current and without an axial current, the several results of the numerical calculation for the stationary state having no axial current are given. (auth) (NSA of Japan)

21821 LINEAR PLASMA CURRENT MULTIPOLE EXPERIMENT. Kamashima, Nobuki; Mori, Shigeru (Japan Atomic Energy Research Inst., Tokai). Kakuyugo Kenkyu; 24: 201-8 (Jan 1970). (In Japanese).

An equilibrium of plasma current multipole configuration is studied in a linear machine. Two plasma current columns are formed in a system bounded by a metal cylinder shaped in a quadrupole-like magnetic field line. These two current cylinders are not in equilibrium, and move towards center due to their own attractive force. This movement can be suppressed by an external magnetic field produced by a pair of currents flowing in the same direction to the plasma currents. (NSA of Japan)

Thermonuclear Processes

Refer also to abstract 22049.

21822 (UCRL-50002-69, pp 29-77) MAGNETIC MIRROR PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

Research on the following areas is described: (1) multistage high-compression experiments, (2) Alice research, and (3) direct conversion and electrostatic confinement studies. (M.O.W.)

21823 (UCRL-50002-69, pp 78-115) ASTRON PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

The following areas of research during this period are discussed: (1) trapping in Astron with resistors, (2) light observations and plasma density measurements in the Astron experiment, (3) x-ray measurements during Astron trapping runs, (4) observations of rf oscillations in Astron, (5) diagnostics of new Astron accelerator, and (6) note on beam dynamics on Astron-type accelerators. (M.O.W.)

21824 (UCRL-50002-69, pp 116-50) TOROIDAL CONFINEMENT PROGRAM. (California Univ., Livermore. Lawrence Radiation Lab.).

Research results are presented on the following area: (1) Levitron experimental results, (2) superconducting Levitron, (3) numerical and experimental studies of toroidal magnetic fields, (4) Hybritron experiment, and (5) Alkmet plasma facility. (M.O.W.)

21825 (UCRL-50002-69, pp 168-91) ENGINEERING DEVELOPMENT. (California Univ., Livermore. Lawrence Radiation Lab.).

Mechanical engineering developments on the 2X multistage compression facility, Alice Baseball II facility, Astron, and the superconducting Levitron are reported. (M.O.W.)

21826 FEASIBILITY OF THERMONUCLEAR REACTORS. Valentini; Hans-Burkhard (Institut fuer Magnetohydrodynamik, Jena, Ger.). Pr. Inst. Masz. Przeply.; No. 46, 27-45(1969). (In German).

From 2nd Seminar on Applied Magnetohydrodynamics and High Temperature Gasdynamics, Prague, Czechoslovakia. See CONF-680558.

A brief review is given of the prospects of power generation by controlled thermonuclear reactions, and of conditions under which a thermonuclear reactor can produce effective power. The way of improving the energy balance of a special type of thermonuclear reactor is given. In this reactor, T and ^{3}He ions generated in plasma and escaping from it may increase the T ions and ^{3}He ions

concentration attainable, if almost all the ions are fed back into the plasma and employed in a nuclear fusion. Particularly advantageous conditions occur when such a complete re-collection of ions is attained, and simultaneously the plasma taken out of the reactor is utilized in a high-efficiency heating of fuel. Conditions stipulating reactor dimensions are clearly given in form of a density–radius diagram. The maximum permissible reactor radius is larger than the desired minimum radius only for plasma densities lower than critical. The present state of experimental research on heating and confinement of high-temperature plasma is also briefly surveyed, as well as some problems important in the field of nuclear fusion research. (auth)

Wave Phenomena

21827 (AEC-tr-7135) WAVE EQUATIONS APPROXIMATING THE PRECISE SOLUTIONS FOR NONLINEAR ELECTRODYNAMICS AND OPTICS. [PART] II. Eleonskii, V. M.; Silin, V. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17915. 33p. Dep. CFSTI.

An abstract of the original Russian report appears as NSA 23: 36735.

21828 FREQUENCY SHIFT DUE TO NONLINEARITY IN PLASMA OSCILLATION. Midzuno, Yukio (Nagoya Univ., Japan). Kakuyugo Kenkyu; 24: 223-8(Jan 1970). (In Japanese).

Frequency shift of the plasma oscillation due to the finiteness of the amplitude is investigated by the use of the asymptotic method of Bogolyubov and Mitropolskii for a one-dimensional warm electron plasma in the fluid description. The frequency shift vanishes in the limit of cold plasma in accordance with various authors. The shift derived by Sturrock is shown to be a Doppler shift due to the presence of the uniform motion of the plasma, which strayed into his formulation. (auth)

21829 STRUCTURE OF EVOLVING ION-ACOUSTIC FRONTS IN COLLISIONLESS PLASMAS. Mason, Rodney J. (Bell Telephone Labs., Inc., Whippany, N. J.). Phys. Fluids; 13: 1042-8 (Apr 1970).

Exact analytic solutions are obtained to the linearized, two-species Maxwell–Vlasov equations for the evolution of an initial step-function density discontinuity in an initially neutral, collisionless plasma. These solutions have been evaluated numerically for hydrogen plasmas with starting temperature ratios $0 \leq \theta = T_e/T_i \leq 30$, for times $0 \leq \tau = \omega_{pi}t \leq 100$, and over distances into the original low-density region $0 \leq \eta = x/A_i t \leq 12$, where A_i is the mean thermal speed of ions. For $\tau \ll 1$ both species simply free stream. By late times ($\tau \gtrsim 30$) quasineutrality of the perturbation has been established, and it is found that: (1) the ion profiles for $\theta \gtrsim 1$ exhibit the appearance of free streaming at an enhanced ion temperature, suggesting that the strong Landau damping usually attributed to the low-θ limit might better be termed "ambipolar free streaming," (2) for $\theta \simeq 5$ they are self-similar and monotonic with a steep leading edge near $\eta = \theta^{\frac{1}{2}}$ followed by a broad, arched trailing edge accounting for half the density rise, and (3) for $\theta \gtrsim 30$ they have a steep but spreading leading edge near $\theta^{\frac{1}{2}}$ and general resemblance to the integrated Airy function profile obtainable through a moment equation treatment retaining only the last damped collective mode. (auth)

21830 PROPAGATION OF LOW-FREQUENCY ELECTROSTATIC WAVES IN A MAGNETIC FIELD. Joyce, Glenn (Univ. of Iowa, Iowa City); Dory, R. A. Phys. Fluids; 13: 1017-20(Apr 1970).

The properties of low-frequency electrostatic waves propagating at various angles to a magnetic field in a plasma are studied. Numerical calculations are used to determine the phase velocities, group velocities, damping decrements, and propagation directions for frequencies between zero and twice the ion cyclotron frequency. A model is presented which simulates experimental time-of-flight studies of finite wave packets generated by sine wave bursts. (auth)

21831 ION DRIFT WAVE INSTABILITY. Freidberg, J. P.; Wesson, J. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 13: 1009-16(Apr 1970).

In hydromagnetically unstable, shearless plasmas the flute mode, $k_{\parallel} = 0$, is stabilized for sufficiently large $k_{\perp}$ by finite Larmor radius effects. It has been widely assumed that this mode is the worst. It is shown that this is not generally correct. In particular, those model which are finite Larmor radius stabilized for $k_{\parallel} = 0$ are unstable for $0 < k_{\parallel} < k_c$, where k_c is identical to the hydromagnetic marginal wavenumber. The instability is due to an ion resonance with the ion drift wave. (auth)

21832 TECHNIQUE FOR DETERMINING THE PROPAGATION CHARACTERISTICS OF INSTABILITIES. Lee, D. A. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio); Soper, G. K.' Phys. Fluids; 13: 995-1006(Apr 1970).

A method for obtaining an approximation to the large-time behavior of instabilities which are represented by multidimensional Fourier integrals of a type which arises in dispersion relation studies is discussed. Applications to moving striations, the beam-plasma instability, and to the ion-cyclotron resonance instability are given and the results compared with those of other methods. (auth)

21833 WAVE INSTABILITIES IN PARTLY IONIZED GASES. Morin, Stephen; Kahn, David (Electronics Research Center, Cambridge, Mass.). Phys. Fluids; 13: 945-55(Apr 1970).

A collisional theory of longitudinal wave propagation in partly ionized, multitemperature gases is formulated from a coupled set of Maxwell and Boltzmann equations. Equations of motion for the three plasma constituents (electrons, ions, and neutrals) are developed by expanding the particle distribution functions in series of Hermite polynomials about equilibrium, Maxwellian distributions which are specified by the macroscopic temperatures of the various plasma species. Employing the equations of continuity, momentum, and energy (inviscid approximation), we obtain a dispersion equation relating the propagation constant to the wave frequency for small amplitude, longitudinal waves. It is found that all three propagation modes (neutral, ion, and electron waves) exhibit instabilities under conditions determined by the wave frequency and the temperature differences among the plasma components. Numerical and analytic data are presented to illustrate these wave instabilities, with particular emphasis being placed upon propagation in weakly ionized gases. (auth)

21834 INTERACTIONS OF WAVES AND PARTICLES IN AN INHOMOGENEOUS ONE-DIMENSIONAL PLASMA. Kaufman, Allan N.; Nakayama, Toshio (Univ. of California, Berkeley). Phys. Fluids; 13: 956-65(Apr 1970).

When a one-dimensional plasma is confined by a static potential, the electric field fluctuations can be described in terms of normal modes. A mode interacts resonantly with a particle whose bounce frequency is an integral submultiple of the mode eigenfrequency. This leads to energy exchange and quasi-linear diffusion of particles. Kinetic equations are derived for the evolution of mode energy, due to wave emission and to damping or growth; and for the evolution of the particle distribution in action space, due to radiation reaction and quasi-linear diffusion. These equations have an H theorem, implying an approach to thermal equilibrium (in the absence of neglected effects). The mode–particle coupling coefficient is expressed explicitly, and is approximated for the limiting cases of high eigenfrequency and of short wavelength. (auth)

21835 MODE COUPLING AT THE BOUNDARY OF A RELATIVISTIC COLLISIONLESS PLASMA. Imre, Kaya; Ozizmir, Ercument (City Univ. of New York, Staten Island). Phys. Fluids; 13: 1080-8(Apr 1970).

The exact solution of the linearized transmission and reflection problem for electromagnetic waves obliquely incident on a half-space relativistic Vlasov plasma is obtained in the case when the electric field is polarized in the plane of incidence. It is assumed that electrons are reflected specularly at the boundary, and ion dynamics is ignored. Coupling of transverse and longitudinal components at the boundary and their propagation characteristics are studied in detail. Numerical results for the calculation of the skin depth and the phase velocity of the discrete modes in the first Riemann sheet are included. (auth)

21836 OSCILLATIONS OF A WEAKLY INHOMOGENEOUS PLASMA WITH COLLISIONS. Bajwa, G. S.; Srivastava, K. M. (Univ. of Jodhpur, India). Phys. Fluids; 13: 1105-6(Apr 1970).

The oscillations are damped when the collision term is incorporated in the study of the oscillations of a weakly inhomogeneous plasma. It was also established that the resonance and cutoff frequencies are not identical for zero curvature of the field lines. (auth)

21837 ION ACOUSTIC WAVE PROPAGATION NEAR THE ION CYCLOTRON FREQUENCY. Ceglio, Natale M.; Lidsky, Lawrence M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 13: 1108-10(Apr 1970).

An experimental investigation of ion–acoustic wave propagation near the ion-cyclotron frequency is described. The acoustic wave was found to propagate along the plasma column in other than a plane wave mode, but no cyclotron resonance effects were observed. (auth)

21838 INTERACTION OF THREE PLASMA WAVES IN A CYLINDRICAL WAVEGUIDE. Spithas, E. N.; Manheimer, Wallace M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 13: 1110-12(Apr 1970).

Three-wave interaction in a cold, collisionless, uniform plasma filling a circular waveguide is studied. Selection rules and matrix elements are obtained. (auth)

21839 SCATTERING OF ELECTROMAGNETIC WAVES BY A NONUNIFORM MAGNETIZED PLASMA COLUMN. Greenwald, R. A. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids; 13: 1112-14(Apr 1970).

A comparison is made between the complete electromagnetic and a quasi-static solution for the upper hybrid resonance scattering spectrum from an infinitely long, radially inhomogeneous, magnetoplasma column to determine when the latter solution is in error. (auth)

21840 EXPERIMENTAL INVESTIGATION OF HARMONIC ION CYCLOTRON WAVE COUPLING AND PROPAGATION ON A CYLINDRICAL PLASMA COLUMN. Dodge, Nathan Bayne. Austin, Tex.; Univ. of Texas (1969). 196p.

Thesis.

Power coupling, propagation and damping, and plasma heating characteristics of harmonic ion cyclotron waves are experimentally investigated. Waves are excited on a cylindrical plasma column prepared by a pulsed PIG discharge. Up to 30 kW of pulsed power is supplied by a 5.8 MHz crystal-controlled transmitter, transmission-line coupled to a two-wavelength Stix Coil through a directional coupler and impedance matching circuit. The plasma is located in a uniform (± ⅓%) axial magnetic field and adjacent "magnetic beach" region for wave damping and plasma heating studies. The maximum magnetic field in the Stix Coil (uniform) region of magnetic field is 10.6 kG. Diagnostic equipment includes magnetic and diamagnetic loop probes, an 8 mm microwave interferometer for plasma density measurements, and voltage and current probes for power measurements in conjunction with the directional coupler. Harmonic ion cyclotron wave propagation and damping is observed up to the fourth harmonic in hydrogen plasma and up to the tenth or eleventh in deuterium plasma. In the latter case, the close spacing of the harmonic fields makes determination of the exact harmonic number difficult. The wave propagation is pressure dependent, higher harmonics propagating at higher pressures. Propagation of more than one harmonic at a given pressure is observed, indicating the pressure dependence is indirect. Over the range of plasma densities obtainable (5×10^{10} to 10^{12} cm^{-3}) wave propagation is found to be independent of plasma density, in agreement with the unbounded plasma theory of quasistatic ion cyclotron waves. Power coupling to the waves is found to decrease with increasing harmonic number in hydrogen and deuterium. Power coupling is found to be inefficient, and always below 18%. Plasma heating is also found to decrease with increasing pressure. Heating up to 8 eV is attained at the fundamental in deuterium but at the higher harmonics in both gases the temperature increase is 1 eV or less. The propagation of the harmonic ion cyclotron wave is found to depend sensitively on plasma temperature, in agreement with the bounded quasi-static ion cyclotron wave theory. Varying the neutral pressure is found to vary the initial plasma temperature. The wave-coupling mechanism is investigated by the use of unshielded, partially shielded, and well-shielded Stix Coils. The unshielded coil is found to increase power coupling and plasma heating, while the well-shielded coil excites no harmonic waves. This result verifies that wave coupling is electrostatic, and a secondary effect due to stray-field coupling in the case of the Stix Coil. The development of the PIG discharge is described. The observation of some nonlinear wave phenomena are reported, and a brief study of the "fast" hydromagnetic wave is described. (Diss. Abstr.)

21841 STOCHASTIC HEATING OF A NONLINEAR WAVE. Filonenko, N. N. (Novosibirsk State Univ.). Dokl. Akad. Nauk SSSR; 189: 1208-10(21 Dec 1969). (In Russian).

The purpose of this study is to show that the energy jump to a nonlinear wave because of an external random source is essentially analogous to the stochastic acceleration of charged particles. The effect of stochastic heating of a nonlinear wave can be observed under conditions where damping of the wave because of collisions and other factors is small. The spectral properties of the noise do not vary with time, and are determined mainly by the external source. It is shown that a definite part of the energy is transformed upwards to the energy of a regular collective motion, as a result of which the energy and also the amplitude of the nonlinear wave increase with time analogous to the process where stochastic particle acceleration takes place. Differences between the particles and the wave in the character of the stochastic energy jump are related with the spectral properties of the latter. It is established that the process of an energy in going to the wave is accelerated by an increase in wave amplitude, and apparently may be interrupted only by overcoming the amplitude. (TTT)

21842 HIGH-FREQUENCY FORCES ACTING ON THE BOUNDARY OF A MAGNETOACTIVE PLASMA AND VACUUM. Petrzilka, V. A. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 20: 331-6(1970).

Using the tensor of time-averaged stresses, a study is made of the force which an electromagnetic wave exerts on the "sharp" plasma–vacuum boundary and on the volume of bounded plasma under the assumption that the magnetostatic field is parallel to the plasma–vacuum boundary. (auth)

Shielding

Refer also to abstracts 21024 and 22036.

21843 MULTIPLE-SCATTERING ANALYSIS BY DIFFUSION AND MONTE CARLO METHODS. Brinkworth, B. J.; Harris, D. O. (University Coll., Cardiff, Wales). J. Phys., D (London); 3: 397-405(Mar 1970).

An account is given of the development, and verification by experiment, of a Monte Carlo method for obtaining the flux of radiation around a point source in an atmosphere of scattering particles, having an absorbing boundary. It is shown that the method gives satisfactory solutions in regions close to the boundary, where an earlier diffusion method became inaccurate. The two methods have complementary features which make it profitable for them to be used in conjunction, each in the domain in which it is most accurate and convenient. (auth) (UK)

21844 SHIELDING OF RADIATION FLUX FROM A CYLINDRICAL SELF-ABSORBING SOURCE IN AXIAL DIRECTION. Krueger, F. W.; Seeligmann, P. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 12: 390-4(Dec 1969). (In German).

The tables of an integral function given in a previous paper for the calculation of radiation flux from a cylindrical self-absorbing source behind a shield in axial direction are extended. (auth)

21845 COMPUTER CODES FOR SHIELDING CALCULATIONS, 1969. Trubey, D. K.; Maskewitz, Betty F. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design; 10: 505-17(Aug 1969).

An extensive library of computer codes useful for radiation transport or shielding calculations is available from the Radiation Shielding Information Center at Oak Ridge National Laboratory. In addition to the point kernel, Monte Carlo, and discrete ordinates codes used for neutron and gamma-ray transport calculations, the collection includes cross-section libraries and codes for processing cross sections, calculating fission product inventories, proton penetration of spacecraft, electron-photon transport, and analyzing neutron activation detector data to determine spectra. A list of the most current codes is given and essential information for each is included. (auth)

21846 REFLECTION OF FAST NEUTRONS FROM BARRIERS. Gromov, V. P.; Gromova, L. L.; Zubov, Yu. F.; Pozdneev, D. B. At. Energ. (USSR); 27: 340-2(Oct 1969). (In Russian).

A Monte Carlo method was used for calculating the fast neutron reflection from shieldings of C, Be, BeO (1.67, 1.84, and 2.96 g/cm^3, respectively) with various primary sources of radiation. Simulation of neutron spectra (d–d source) and ^{235}U fission by thermal neutrons was calculated, using previously developed formulas. A computer was used for calculating 10,000 events for each material and angle of incidence. Graphical data are given on the angle of distribution of reflecting neutrons as a function of the cutoff threshold. (R.V.J.)

21847 FIZICHESKIE OSNOVY ZASHCHITY OT IZLUCHENII. (Physical Principles of Radiation Protection). Gusev, N. G.; Kimel, L. R.; Mashkovich, V. P.; Pologikh, B. G.; Suvorov, A. P. Zashchita ot Ioniziruyushchikh Izluchenii. Tom I. (Shielding of Ionizing Radiation. Volume I). Moscow; Atomizdat (1969). 472p.

Physical aspects of ionizing radiation protection are discussed. The units of radioactivity and ionizing radiation are estimated, and maximum flux densities and permissible concentrations of radioactive isotopes in the air and in water are calculated. Elementary interaction processes of charged particles, γ quanta, and neutrons with matter are analyzed, and numerical, analytical, and semi-emperical calculation methods for radiation penetration through shielding, nonscattering radiation fields, and fields of γ and neutron scattering in shielding media are described. Practical methods for calculating protection against ionizing radiation are included. (82 references) (R.V.J.)

Solid-State Physics

Radiation Effects

Refer also to abstracts 20828 and 21543–21547.

21848 (AWRE-O-9/70) THIN FILM CERMET STRUCTURES FORMED BY ION BOMBARDMENT. Perkins, J. G.; Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston (England)). Jan 1970. 13p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

Experiments are described in which thin film layers exhibiting typical cermet characteristics were formed by argon-ion bombardment of metal-insulator-metal sandwich structures. The resistance of the insulating layer may be changed in a controlled manner by varying the dose of incident ions and changes in resistance of eight orders of magnitude have been observed. A qualitative mechanism involving sputtering is suggested, and reasonable agreement between experimental results and calculations based on current sputtering theories is found. (auth)

21849 (CEA-CONF-1487) INTERNAL FRICTION IN LOW TEMPERATURE IRRADIATED B.C.C. METALS. Hivert, V.; Pichon, R.; Bilger, H.; Bichon, P.; Verdone, J.; Dautreppe, D.; Moser, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1969]. 27p. (CONF-690944-1). Dep. CFSTI (U. S. Sales Only).

From International Conference on Ultrasonic Attenuation and Internal Friction in Crystalline Solids, Providence, R. I.

Internal friction peaks observed on irradiated iron and molybdenum are presented. An interpretation is proposed, which supposes a one-interstitial model. (auth)

21850 (COO-125-55) BASIC RADIATION DAMAGE STUDIES. Technical Progress Report, December 15, 1968-December 15, 1969. (Purdue Univ., Lafayette, Ind. Dept. of Physics). 30 Dec 1969. Contract AT(11-1)-125. 5p. Dep. CFSTI.

Research on electron irradiation of Si and Ge at low temperatures is reported. The effects of a 10°K irradiation on the A centers produced in Si by electron irradiation at 80°K are studied. Impurity and annealing effects in n- and p-type Ge are being studied. (D.L.C.)

21851 (COO-1800-7) DEFECT MOBILITY AND REACTION: DIFFUSIONAL AND RATE THEORY FORMULATIONS IN ONE AND THREE DIMENSIONS. Simpson, M.; Sosin, A. (Utah Univ., Salt Lake City). [1969]. Contract AT(11-1)-1800. 72p. Dep. CFSTI.

The migration of defects, leading to eventual reaction, is analyzed on the basis of diffusion theory and compared with chemical rate theory. A diffusional treatment is carried out in detail and in special cases of particular interest. Correlations between interstitials and vacancies, typical of metals following electron irradiation, are examined. Trapping by impurities and dislocations, thermal conversion, and high-temperature bombardment are also treated. In each case, formulations are developed along both one- and three-dimensional diffusion models. These alternative results are compared with experiments, particularly, annealing in copper irradiated by electrons at low temperature. The results support the conclusion that the defect which migrates in Stage I diffuses in three dimensions. (auth)

21852 (JUL-604-FN) DEFECT HOLES IN ELECTRON-IRRADIATED METALS BY DIFFUSION OF INTERSTITIAL ATOMS. Schroeder, Kurt (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Jul 1969. 91p. (In German). Dep. CFSTI (U. S. Sales Only).

The recovery of Frenkel pairs by isotropic diffusion of interstitial atoms is calculated for small defect densities with consideration of the formation of interstitial atom clusters. In electron irradiation, interstitial atom-vacancy pairs are produced homogeneously in the crystal. The distance R within a pair possesses a distribution function f(R). For small densities, the mean distance of the pairs is large in comparison with the distance within a pair. At the beginning of the diffusion, the interstitial atom reacts only with its correlated vacancy and only the defects that survive this correlated recovery can, after diffusion, enter into other reactions over wide gaps. The correlated recovery is first treated and the fraction g of the remaining defects is calculated as a function of the distance distribution f(R). In diffusion over wide gaps, defects react with each other, which is not correlated through (uncorrelated recovery). The rate equations are derived from the general density equations with consideration of the formation of interstitial atom clusters using the superposition approximation. It is assumed that the defects are distributed statistically independent and that the defect densities are small. The interaction of the defects is described by spherical interaction volume, in which the interaction occurs instantaneously. With special assumptions on the dependence of the interaction radii R_n of the n-clusters for capture of another interstitial atom on the number n of assembled interstitial atoms, the rate equations can be solved. The time dependence of the density, the final density of the vacancies, and the distribution of the interstitial atom cluster can be calculated. The dependence of the results on the ratio of the interaction radius of the cluster to the annihilation radius of the vacancy is discussed. The theory is compared with experimental results on the recovery of radioinduced electrical resistances in Cu, Al, and Pt. In appendices the details of the calculations are given. (tr-auth)

21853 (ORNL-tr-2279) TEMPERATURE DEPENDENCE OF FAST PROTON CHANNELING IN Si SINGLE CRYSTALS. Kononov, B. A.; Struts, V. K. Translated by George E. Moore (Oak Ridge National Lab., Tenn.), from Izv. Vyssh. Ucheb. Zaved., Fiz.; 12: No. 7, 131-2(1969). 3p. Dep. CFSTI.

The effects of temperature on the channeling were investigated for Si single crystals of 80-micron thickness and aligned with the (110) axis coinciding with the incident proton beam. The energy distribution of the protons and the fraction of channeled protons both show that the channeling drops as the temperature increases, practically disappearing at 800°K. The temperature dependence is proposed to be due to increased probability of Rutherford scattering. (D.L.C.)

21854 RADIATION ENHANCED DIFFUSION IN FACE CENTERED CUBIC Cu-Zn ALLOYS. Schuele, W.; Lang, E.; Donner, D.; Penkuhn, H. (EURATOM, Ispra, Italy). Radiat. Eff.; 2: 151-63(Feb 1970).

The enhancement of diffusion by neutron irradiation was investigated on a Cu-36 percent Zn alloy for various neutron fluxes and irradiation temperatures by means of in-pile measurements of electrical resistivity. For fresh samples, the diffusion rate depends on temperature with an activation energy of 0.35 eV. During repeated irradiations, the diffusion rate decreases and becomes nearly temperature-independent. The variation of the concentration of interstitials and vacancies with irradiation time has been numerically calculated for various neutron fluxes, irradiation temperatures, and sink concentrations. A comparison of the experimental and theoretical results shows that the point defects annihilate in fresh samples mainly by pair recombination and in samples which had been repeatedly cycled by pair recombination and at fixed sinks. Point-defect clusters acting as sinks are created during the course of the irradiation as shown by electron microscope investigations. The radiation-enhanced diffusion rate was found to depend on interstitials only, the activation energy of which was determined to be 0.70 eV. (auth)

21855 GAMMA-RAY, X-RAY, AND ULTRAVIOLET LIGHT INDUCED LOW-TEMPERATURE THERMOLUMINESCENCE OF KN_3 AND NaN_3. Townsend, P. D. (Picatinny Arsenal, Dover, N. J.); Kemmey, P. J.; Levy, P. W. Radiat. Eff.; 2: 141-9(Feb 1970).

When KN_3 and NaN_3 powders or single crystals are irradiated with γ rays, X rays, or ultraviolet light at liquid helium or nitrogen temperatures and subsequently heated, many thermoluminescent glow peaks are observed between 47 and 255°K. The KN_3 glow curves have been analyzed by four different procedures. Thus four values of the activation energy have been obtained for each peak, and these occasionally differ by as much as 50 per cent. However, the agreement is usually much better. One of these analyses, a numerical kinetics treatment employing a large computer, has been used to determine the activation energies and the preexponential factors listed below for the more intense glow peaks from both KN_3 and NaN_3. The temperature of the glow peak maxima in °K, the activation energy in eV, and the preexponential factor in sec^{-1} obtained for the five most prominent KN_3 peaks are: 109, 0.28, 1.0×10^{11}; 123, 0.29, 2.3×10^{10}; 142, 0.32, 7.7×10^{10}; 211, 0.63, 1.5×10^{13}; 245, 0.84, 1.0×10^{15}. The corresponding values for the nine most prominent NaN_3 peaks are: 47, 0.067, 1.4×10^{5}; 52, 0.046, 10^{2} to 10^{5}; 117, 0.23, 6.6×10^{7}; 133, 0.26, 3.5×10^{7}; 175, 0.38, 2.0×10^{8}; 189, 0.38, 2.0×10^{8}; 205, 0.39, 3.7×10^{8}; 233, 0.37, 1.5×10^{8}; 255, 0.47, 6.2×10^{8}. A few of these NaN_3 glow peaks might possibly be related to previously observed ESR and/or color centers. (auth)

21856 THE INTERPRETATION OF RADIATION DAMAGE EXPERIMENTS ON GOLD. Seeger, A. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Radiat. Eff.; 2: 165-73(Feb 1970).

It is shown that the conclusions drawn from recent experiments on electron irradiation of gold at about 100°K should be reversed, i.e., that these experiments speak against the free thermally activated migration of interstitials at the irradiation temperature. It is shown that this viewpoint is in agreement with several related experiments, which may all be interpreted by a dynamic propagation of crowdions over distances between 1000 Å and 2000 Å. At intermediate and high defect concentrations the dynamic propagation mechanism is suppressed. (auth)

21857 THE BULK EFFECT OF POINT DEFECTS ON YOUNG'S MODULUS IN ELECTRON IRRADIATED COPPER. Roth, G.; Naundorf, V. (Kernforschungsanlage, Juelich. Technische Hochschule, Aachen). Radiat. Eff.; 2: 187-92(Feb 1970).

Pairs of copper samples—one for electrical resistivity, the other for Young's modulus measurements—were irradiated simultaneously at 120°K with 3-MeV electrons up to an integrated dose of 2×10^{20} el/cm^2. The effect of dislocation pinning and the bulk effect of point defects on Young's modulus E could clearly be separated. The following relation between the bulk effect $\Delta E/E$ and the resistivity increase $\Delta\rho$[Ωcm] was found: $\Delta E/E = -25 \times 10^4 \times \Delta\rho$. Besides strong annealing in stages II and III (180 to 300°K) and some annealing between 300 to 500°K, stage V annealing (500 to 600°K) also was found. In stage III, the resistivity annealed more than Young's modulus, whereas the converse occurred in stage V. These measurements are discussed in connection with the electron-microscope observation of point-defect clusters after electron irradiation at 120°K and heating to room temperature. (auth)

21858 RECOVERY OF LOW-TEMPERATURE ELECTRON IRRADIATION-INDUCED DAMAGE IN N-TYPE GaAs. Thommen, K. (Atomics International, Canoga Park, Calif.). Radiat. Eff.; 2: 201-10(Feb 1970).

Undoped n-type GaAs was irradiated near 5 and 77°K with electrons having incident energies between 0.46 and 1.30 MeV. The recovery of the electrical resistivity and the Hall coefficient upon annealing from 4 to 520°K was monitored. Changes which occurred upon annealing below 200°K could be reversed by ionizing radiation. A small amount of irreversible ionization-induced recovery was observed after irradiation near 5°K. Major irreversible recovery stages were centered near 235 (stage I), 280 (stage II) and 520°K (stage III). Recovery in stage I and II obeyed first order kinetics. The activation energies of stages I and II were determined as 0.72 and 0.83 eV, respectively. The carrier concentration changes per unit irradiation dose corresponding to the three recovery stages differed in their energy dependence indicating that the defects which are removed in stage III have the lowest threshold energy. The carrier concentration changes per unit irradiation dose corresponding to stages I and III were higher for irradiation near 5°K than for irradiation near 77°K. (auth)

21859 ANISOTROPIC CONDUCTIVITY CHANGES OF NEUTRON-IRRADIATED Si CRYSTALS. Abdullaeva, D. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 76-7(1969). (In Russian).

Pure metals and semiconductors, such as Al and Si, exhibit a similar behavior upon exposure to radiation: at 30°C no radiation damage is observed because of annealing effects but damage may be observed in Al upon exposure at 20°K. Study of the electrical conductivity of Si and Ge revealed that the annealing curves are step-shaped. The temperature of total annealing of metals depends on the atomic weight; complexes formed in Al and Si are annealed out at a lower temperature than those formed in Au and Ge. The anisotropy of radiation damage in crystals is due to the anisotropy of the elastic deformation. The deformation depends on the packing density of the various crystal planes. The effect was examined by studying phenomena in the (111), (110), and (100) planes, on the basis of their behavior upon annealing of n-Si single crystals exposed to 10^{18} n/cm^2 of fast neutrons. Defects in the (110) plane were found to cause the largest amount of conductivity changes which could be annealed at a faster rate. It was concluded that semiconductors also form complexes, as do metals. (TTT)

21860 A SEARCH FOR CHEMICALLY BOUND NEUTRONS IN LiF AT 4°K. Isaak, G. R.; Berovic, N.; Dunscombe, P. D.; Gough, C. E.; Hacking, D.; Hawkesworth, M. R.; McKee, J. S. C.; Reece, B. L.; Solaija, T. J. (Univ. of Birmingham, Eng.). Phys. Lett.; 31B: 63-4(19 Jan 1970).

For the existence of a neutron–electron bound state in LiF Grant and Cobble recently reported evidence. This letter reports the results of a similar experiment, which puts an upper limit on the cross section for production of delayed neutrons 50 times lower than that reported by Grant and Cobble. (auth)

21861 STUDIES ON BOMBARDMENT-INDUCED DISORDER. II. FORMATION OF ION-BOMBARDMENT-INDUCED DISORDER IN ZIRCON, CORUNDUM, AND DIAMOND. Jech, Cestmir; Kelly, Roger (McMaster Univ., Hamilton, Ont.). J. Phys. Chem. Solids; 31: 41-8(Jan 1970).

The release of ^{85}Kr from zircon, corundum, and diamond, following its injection at 10 keV, can be effected both by dissolution of surface layers disordered by the ion bombardment or alternatively by thermal annealing of the disorder. Such release was used to investigate the progress of disordering as a function of ion-bombardment dose. Both techniques were found to give comparable results and with zircon a close agreement with disordering by alpha recoils, as studied by Holland and Gottfried (1955), was also found. The results are interpreted in terms of a threshold dose and a subsequent, rapid transformation of the crystalline solid into a disordered (amorphous) state. The mean numbers of atoms transferred to the disordered phase per ion impact were determined and found to be 300 for zircon, 150 for corundum, and 110 for diamond. A tentative explanation for this sequence is suggested based on the ease with which the disorder anneals. (auth) (UK)

21862 STUDIES IN RADIATION EFFECTS IN SOLIDS. VOLUME 3. Dienes, G. J. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969). 345p.

Two comprehensive articles are presented on Radiation Effects in Magnetic Materials and Atomic Displacement Mechanism in Metals and Semiconductors. Separate abstracts were prepared for both. (D.L.C.)

For abstracts of individual chapters see: 21863 and 21864.

21863 RADIATION EFFECTS IN MAGNETIC MATERIALS. Dautreppe, D. (CEN, Grenoble, France). Stud. Radiat. Eff. Solids; 3: 1-151(1969).

This review consists of: a general survey of the effects of defects on magnetic properties; fundamental aspects in pure ferromagnetic metals, ferromagnetic alloys, and superparamagnetic alloys; and technological aspects in soft and hard magnetic alloys, ferrimagnetic and antiferrimagnetic materials, and thin films. 185 references. (D.L.C.)

21864 ATOMIC DISPLACEMENT MECHANISM IN METALS AND SEMICONDUCTORS. Sosin, A. (North American Rockwell Science Center, Thousand Oaks, Calif. Univ. of Utah, Salt Lake City); Bauer, W. Stud. Radiat. Eff. Solids; 3: 153-327(1969).

A review is presented of a variety of displacement effects which have been observed or proposed. After a discussion of displacement theory and interpretation of experiments, irradiations of metals and semiconductors in the low-energy, low-dose range and in the high-energy, high-dose, high-temperature range are reviewed separately. 188 references. (D.L.C.)

21865 PHYSICS OF ICE. Proceedings of the International Symposium, Munich, Germany, September 9–14, 1968. Riehl, Nikolaus; Bullemer, Bernhard; Engelhardt, Hermann (eds.). New York; Plenum Press (1969). 659p. $25.00. (CONF-680963).

A total of 56 papers are presented under the following headings: crystal structure and growth, hydrogen bonding, radiation chemistry, mechanical properties, lattice dynamics, thermal phenomena, electric properties, diffusion and relaxation phenomena, and glaciology and meteorology. Separate abstracts were prepared for 4 papers dealing with radiation effects and isotope effects. (D.L.C.)

For abstracts of individual chapters see: 20764, 20804, 21866, and 21867.

21866 NEUTRON- AND GAMMA-ACTIVATED NUCLEATION OF TYNDALL-FLOWERS IN ICE. Mueller-Krumbhaar, H. (Technische Hochschule, Munich). pp 132-7 of Physics of Ice. /Riehl, Nikolaus (ed.). New York; Plenum Press (1969).

From International Symposium on Physics of Ice, Munich, Germany. See CONF-680963.

Lattice disturbances are created in otherwise perfect ice single crystals by neutron and γ irradiation. These imperfections act as nucleation centers for internal melting when infrared energy is absorbed. The shape of these Tyndall flowers as well as their distribution and annealing properties exhibit different behavior characteristics of the irradiation. (auth)

21867 FORMATION AND STRUCTURE OF COLOUR CENTRES IN IRRADIATED ICE. Weiss, J. J. (Univ. of Newcastle-upon-Tyne, Eng.). pp 195-6 of Physics of Ice. /Riehl, Nikolaus (ed.). New York; Plenum Press (1969).

From International Symposium on Physics of Ice, Munich, Germany. See CONF-680963.

A mechanism for the formation of radioinduced trapped electrons (color centers) in ice is suggested: irradiation decomposes a water molecule, creating a vacancy where an electron can be trapped; diffusion of Bjerrum D defects results in a rotation of two water molecules to point their protons toward the vacancy. (D.L.C.)

21868 CHANNELING EFFECT AND ITS APPLICATIONS TO ION IMPLANTATION PHENOMENA. Eriksson, Lennart. Stockholm; Kungliga Tekniska Hogskolan (1969). 16p.

Thesis.

The present work deals with aspects of the channeling effect and

its applications to the study of ion-implanted semiconductors. The work can be divided into three closely connected parts: range distributions of energetic heavy ions in tungsten single crystals; analysis of lattice disorder and lattice location of implanted atoms in silicon and germanium by channeling effect measurements; and lattice effects on the penetration of light energetic particles in solids. Summaries are presented of publications on these three topics. (D.L.C.)

21869 INFLUENCE OF TITANIUM IMPURITIES ON THE CONCENTRATION OF PARAMAGNETIC DEFECTS IN γ-IRRADIATED ALUMINUM OXIDE. Cox, Ronald (CEA, Grenoble, France). Compt. Rend., Ser. B; 270: 502-5(16 Feb 1970). (In French).

The concentration of trapped holes in γ-irradiated aluminum oxide was measured through electron paramagnetic resonance spectroscopy, and it was shown that it increases with the number of Ti^{4+} ions in the crystal. This result is explained by a reciprocal compensation of the defects of opposite charges. This interpretation was confirmed by oxidation and reduction experiments. The brown color of irradiated aluminum oxide single crystals also increases with the concentration of trapped holes. (France)

21870 SIMPLE DEFECTS IN GERMANIUM CREATED BY HIGH-ENERGY ELECTRONS. Rzewuski, Henryk (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 14: 707-32 (1969). (In Polish).

The properties of simple defects in the crystal lattice of n-type germanium produced by 1-MeV electrons from the Van de Graaff electrostatic accelerators, using dc and pulsed beams, were investigated. In particular, fast processes of metastable defect annealing and their temperature dependence were analyzed using the method of concentrational annealing, and the charge state of simple defects above the annealing threshold of metastable defects were investigated using the method of Hall mobility annealing. The measurements were carried out in the temperature range from 80 to ~200°K. Several new methods of measurement were developed, viz., a pulse method for Hall coefficient measurement and double-frequency and compensation methods for Hall coefficient and Hall mobility measurements. The estimated activation energy E'_R = 0.140 eV for this process differs considerably from that predicted from the present model of MacKay and Klontz. In the study of the charge state of simple defects by the method of isochronal annealing of the Hall mobility, two new annealing thresholds at T_1 = 100°K and T_2 = 140°K were observed. Considering the results obtained, a new model of metastable defect based on the properties of a doubly charged center is proposed and discussed. (auth)

21871 RADIATION EXPANSION OF CaF_2 CRYSTALS. Zavadovskaya, E. K.; Ovcharov, A. T.; Lisitsyn, V. M.; Kalinin, M. I. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 155-6(1969). (In Russian).

Variation of density and absorption spectra in CaF_2 crystals was studied as functions of the proton radiation dose at 4.5 MeV followed by thermal pulse annealing. Data obtained on the kinetics of density change at higher radiation doses show that the density diminished with dose, with the maximum relative change = 2.5×10^{-4}. The observed increase of the volume of the crystal was due to the generated self-defects, rather than color centers responsible for the absorption bands in the spectral region examined. (R.V.J.)

21872 PECULIARITIES OF THE TRANSVERSE MAGNETORESISTANCE EFFECT IN γ-IRRADIATED GLASSES. Belyavskaya, L. M.; Abramets, V. A. (Tomsk Inst. of Radioelectronics and Electron Technology, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 141-3(1969). (In Russian)

Magnetic resistance similar to the magnetic resistance of semiconductors at helium and nitrogen temperature has been previously observed with alkali-telluride glass irradiated with γ rays from 10^5 to 10^7 R (1.25-MeV energy with 200 R/min intensity). Studies were made of the magnetic resistance of glasses of compositions 11 mole % Na_2O–89 mole % SiO_2 irradiated with 1.4×10^6 R and 33 mole % Na_2O–67 mole % SiO_2 irradiated with 1.6×10^6 R in a vacuum and in the atmosphere. The transition of magnetic resistance from negative to positive at not too high doses was observed, while with increased doses the effect always changed sign revealing a typical positive effect. The phenomena were interpreted (as in semiconductors) and a result of localized spins (in the case of the negative effect) and the presence of the Lorentz effect during the simultaneous positive effect. (R.V.J.)

21873 INFLUENCE OF IRRADIATION ON CRYSTAL GROWTH. Motoc, Cornelia (Polytechnic Inst., Bucharest). Rev. Roum. Phys.; 14: 595-602(1969).

The influence of gamma irradiation on potassium dihydrogen phosphate and Rochelle salt crystals grown from water solution was studied. It has been shown that as a result of irradiation, morphological changes and habit modifications occur. These changes are very similar to those occurring in the presence of impurities. These effects may be explained when one takes into account both chemical and physical effects of irradiation. (auth)

21874 ANNEAL BEHAVIOR OF DEFECTS IN ION-IMPLANTED GaAs DIODES. Hunsperger, Robert G.; Marsh, Ogden J. (Hughes Research Labs., Malibu, Calif.). Met. Trans.; 1: 603-7(Mar 1970).

Doping of semiconductors by implantation of high-energy ions creates lattice damage which in general must be removed by annealing to form good quality p/n junctions. Implantation of zinc or cadmium ions into n-type gallium arsenide substrates held at 400°C produces a p/n junction after the samples are annealed at elevated temperature (≥500°C for zinc, ≥600°C for cadmium). However, the resulting junctions are not abrupt; they contain a semiinsulating (I) layer and have a p-i-n structure. The thickness of the semiinsulating layer changes with annealing. For example an implant of 1.3×10^{15} per sq cm, 20 kV, Zn^+ ions produced a junction with an I layer of 28 μ thickness after annealing for 10 min at 600°C. An identically implanted sample, annealed for 10 min at 900°C, had an I layer thickness of 120 μ. A similar increase in I layer thickness with annealing was observed for samples implanted with 20 kV Cd^+ ions at 400°C. Implantation of Zn^+ and Cd^+ ions into GaAs substrates held at room temperature produced junctions with much thinner I layers after annealing than those observed for the 400°C implants. The formation of the semiinsulating layer in the junction and its subsequent variation of thickness with annealing are attributed to deep diffusion of defects during the implantation or subsequent anneal, which produces compensation to the depth where the concentration of defects equals the substrate impurity concentration. The compensating centers are thought to be arsenic vacancy-substrate dopant atom complexes. (auth)

21875 THREE-DIMENSIONAL VERSUS CROWDION MIGRATION OF INTERSTITIALS IN ANNEALING STAGE I OF IRRADIATED METALS. Schilling, W.; Schroeder, K.; Wollenberger, H. (Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi; 38: 245-57(1 Mar 1970).

Formulas for defect production rates are derived for the case where interstitials are highly mobile at the irradiation temperature, thereby either recombining with vacancies or being trapped at impurities. Both the migration of interstitials in three dimensions and the linear migration of crowdions are considered. For the crowdion model, the possibility of thermal conversion is included. Experimental observations of the defect production rates in fcc metals at temperatures above stage I confirm qualitatively that quantitatively all the predictions of the model, which assumes three-dimensional interstitial migration. The predictions of the crowdion model are by orders of magnitude in disagreement with the experimental results: especially, the predicted specific dependence of the defect production rates on the impurity concentration and irradiation temperature is not observed. The interpretation of the dislocation pinning experiments in terms of the crowdion model is criticized. (auth)

21876 DOUBLE-PLASMON EXCITATION IN A FREE-ELECTRON GAS. Ashley, J. C.; Ritchie, R. H. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Phys. Status Solidi; 38: 425-34(1 Mar 1970).

The interaction of a fast charged particle moving in a free-electron gas is described in the random phase approximation (RPA). The mean free path for the second order process of double-plasmon excitation in the free-electron gas is calculated. It is found that the inverse mean free path for the double-plasmon excitation process is related to the inverse mean free path for single plasmon excitation by $\lambda_{2p}^{-1} = 0.0103\, r_s^2\, \lambda_p^{-1}$. Thus, for electron densities corresponding to those in a real metal ($1 < r_s < 6$), double-plasmon excitation may be important in the interpretation of certain experimental results as, for example, characteristic energy loss measurements. (auth)

21877 CHANNELING OF 1.5-MeV PROTONS IN ALKALI-METAL HALIDE CRYSTALS. Mannami, M.; Sakurai, T.; Ozawa, K.; Fujimoto, F.; Komaki, K. (Kyoto Univ. Japan Atomic Energy Research Inst., Tokai, Tokyo Univ.). Phys. Status Solidi; 38: K1-4(1 Mar 1970).

Channeling of 1.5-MeV protons in NaCl, KCl, KBr, and KI single crystals was studied by transmission. (100), (010), (110), and (110) planar channelings and faint {120} blockings were observed. Energy loss spectra in (010) and (110) channelings of NaCl are given. Ratios of energy losses of (100) channeling are tabulated for all four salts, and the observed critical angles for (100) channeling are compared with Thomas–Fermi calculations. (D.L.C.)

21878 ENERGY ANGULAR DISTRIBUTIONS OF ION-EXCITED ELECTRONS FROM A COPPER SINGLE CRYSTAL WITH FIXED

POLAR ANGLE. Hliscs, R.; Binder, H.-J. (Technische Univ., Dresden. Bereich Experimentalphysik I, Dresden). Phys. Status Solidi; 38: K27-9(1 Mar 1970).

Angular distributions were measured at 10 to 23 eV for electrons emitted by bombardment of a Cu crystal face by 24.6-keV Ar ions at 300°C. Maxima and minima appear in the angular distributions if the [110] directions are in the plane spread by the crystal-turning axis and the electron-starting direction, and the maxima–minima differences reach their maximum at ~15 eV. A relief of lines with equal electron yield was drawn from the target current, and the hollows of this relief correspond to the close-packed [110] directions of the fcc lattice. (D.L.C.)

21879 DECREASE IN THE PHOTOLUMINESCENCE YIELD OF MOLECULAR CRYSTALS UNDER ELECTRON BOMBARDMENT. Khan-Magometova, Sh. D. Opt. Spectrosc. (USSR) (Engl. Transl.); 27: 29-34(Jul 1969).

Translated from Opt. Spektrosk.; 27: 61-71(Jul 1969).

Changes in the luminescence spectra of molecular crystals under electron bombardment have been investigated. Formulas have been derived which quite adequately describe the reduction in luminescence intensity as a function of irradiation. (auth)

21880 SCATTERING OF FAST CHARGED PARTICLES ON CRYSTALS. Ryabov, V. A. (Inst. of Physics and Energetics, Obninsk, USSR). Phys. Status Solidi; 38: 63-7(1 Mar 1970).

The angular distribution of fast charged particles scattered on a perfect crystal is studied. By introducing many-particle correlation functions, a velocity distribution function convenient for numerical analysis is obtained. It is shown that this distribution depends essentially on correlations between the thermal atomic displacements of a lattice. A two-particle model is considered as a particular case, and results are compared with experimental data. It is evident that, even in this simplest case, the axial symmetry of the scattering yield is disturbed. This is determined by the difference of the various correlation tensor's components as found. (auth)

21881 THE EFFECT OF 14-MeV AND REACTOR NEUTRONS ON GERMANIUM AT 77°K AND ITS ANNEALING BEHAVIOR. Wolf, D. (Univ., Kiel). Phys. Status Solidi; 38: K93-6(1 Mar 1970).

N- and p-type Ge was irradiated by 14-MeV neutrons at 77°K and isochronally annealed; the resistivity and Hall effect changes were compared with these from reactor neutrons. For p-type Ge, the reverse annealing (100 to 150°K) for 14-MeV neutrons is not so high as for reactor neutrons. An x-ray flash experiment after an anneal showed the expected behavior due to a "two-state defect." For n-type Ge, the annealing stage at 100 to 150°K, observed for reactor neutrons, is entirely absent for 14-MeV neutrons. After an annealing pulse and return to 77°K, a slow decay of the resistivity results for 14-MeV neutrons but not for reactor neutrons. This can be explained if mobile monovacancies are liberated from the disordered regions in the annealing pulse. For reactor neutrons, the vacancies are trapped by small radiation defects outside the regions, and no relaxation results, but an annealing stage below 150°K arises. (D.L.C.)

21882 EFFECT OF ELECTRON IRRADIATION ON THE MINORITY CARRIER MOBILITY AND LIFETIME OF p-TYPE InSb. Euthymiou, P. C.; Ravanos, C. E. (Univ. of Athens). Phys. Status Solidi; 38: K85-8(1 Mar 1970).

The effects of electrons from a $^{90}Sr-^{90}Y$ source on the steady-state photomagnetoelectric effect and photo conductivity of p-type InSb single crystals at 78°K were studied. The minority carrier mobility μ_e and ratio lifetime τ_r were determined from the measurements. μ_e increases with irradiation, but this anneals out a few degrees above 78°K. No definite pattern was observed for τ_r. (D.L.C.)

Physical Properties

Refer also to abstracts 20750, 21440, and 21549.

21883 (CEA-CONF-1476) MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF Pr–Gd ALLOYS. Tissot, L.; Blaise, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1969. 7p. (CONF-691103-3). Dep. CFSTI (U. S. Sales Only).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa.

Various Pr–Gd alloys, covering the whole range of compositions, were studied by x-ray diffraction and static magnetic measurements. The magnetization measurements were made in fields extending to 26 kOe in the temperature range 2 to 500°K. The following phase diagram with the corresponding magnetic properties is found: (1) a Pr-rich phase of double hexagonal structure that is paramagnetic down to 2°K and follows the Curie–Weiss law; (2) a Gd-rich phase of compact hexagonal structure that is ferromagnetic at low temperature; and (3) a phase based on the composition Pr_3Gd_5 of super hexagonal structure (analogous to the structure of Sm) that is antiferromagnetic at low temperature. Two alloys having compositions just either side of this superhexagonal phase were studied. Their magnetic behavior corresponds to that observed in ferrimagnets; the ferromagnetic Curie temperatures are higher than those observed in $Gd_{38}Pr_7$, situated in the Gd-rich phase. (auth)

21884 (COO-1417-4) EXPERIMENTAL STUDY OF THE SURFACE STRUCTURE AND ELECTRONIC PROPERTIES OF SINGLE CRYSTAL MOLYBDENUM AND TUNGSTEN RIBBONS. Final Report, November 1, 1964–October 31, 1969. Morgan, Donald R. (Saint Mary's Coll., Winona, Minn.). 12 Jan 1970. Contract AT(11-1)-1417. 37p. Dep. CFSTI.

Techniques were developed for producing thin single-crystal ribbons of W and Mo, with various amounts of surface disorder. A system was developed for both LEED (low-energy electron diffraction) and Auger studies, and some Auger spectra are given for both Mo and W single crystals. Thermionic emission measurements were made using the retarding-potential method, but the results do not agree with theory. The LEED and Auger results could not be correlated with the thermionic emission constants. (D.L.C.)

21885 (LYCEN-6956) MICROSTRUCTURE EFFECT ON HYPERFINE INTERACTIONS IN Yb–Ag. Beraud, R.; Berkes, I.; Daniere, J.; Haroutunian, R.; Marest, G.; Rougny, R. (Lyon Univ. (France). Institut de Physique Nucleaire). 18 Dec 1969. 18p. (In French). Dep. CFSTI (U. S. Sales Only).

The electronic relaxation time in ^{169}Tm following the beta decay of ^{169}Yb embedded in a dilute Yb–Ag-base alloy and in an isotope separator-implanted source, was determined by time-differential and integral perturbed angular correlation measurements at room temperature. An electric field gradient acting on the ^{169}Tm nucleus was discovered in the alloy, too. These results are thought to come from the precipitation of Yb and the formation of $YbAg_2$ in the dilute alloy. (France)

21886 THE LOW-TEMPERATURE ELECTRICAL AND MAGNETIC PROPERTIES OF $TaSe_2$ AND $NbSe_2$. Lee, H. N. S.; Garcia, M.; McKinzie, H.; Wold, A. (Brown Univ., Providence). J. Solid State Chem.; 1: 190-4(Jan 1970).

$NbSe_2$ has been reported to have an anomalous sign change in the Hall coefficient at low temperatures. It is shown that the sign change is associated with a magnetic ordering. In addition, electrical and magnetic studies have been carried out on $TaSe_2$, and a similar anomalous sign change is observed in the Hall coefficient at about 90°K. A small degree of magnetic ordering is also present in this compound near the temperature at which the Hall coefficient begins the rapid change from p- to n-type. (auth)

21887 ON THE MAGNETIC BEHAVIOR OF NEW 2H-NbS_2-TYPE DERIVATIVES. Hulliger, Fritz; Pobitschka, Eva (Cyanamid European Research Inst., Geneva). J. Solid State Chem.; 1: 117-19(Jan 1970).

The magnetic behavior of compounds of the type T_xNbS_2, T_xNbSe_2, T_xTaS_2, and T_xTaSe_2 with $x = \frac{1}{3}$ and $x = \frac{1}{4}$ was studied below room temperature. No magnetic order was found with T = Ti and V, whereas with Cr the phases with $x = \frac{1}{3}$ become ferromagnetic. (auth)

21888 DEBYE TEMPERATURES OF HOLMIUM AND DYSPROSIUM FROM SINGLE-CRYSTAL ELASTIC CONSTANT MEASUREMENTS. Palmer, S. B. (Univ. of Hull, Eng.). J. Phys. Chem. Solids; 31: 143-7(Jan 1970).

The elastic constants of single crystals of Dy and Ho were measured from 330 to 1.5°K. The moduli at 0°K, obtained by extrapolation, are used to calculate the Debye temperature, θ, of the two materials. Values obtained are for Dy, θ = 183°K and for Ho, θ = 188.5°K. These are compared to the values of θ obtained from specific heat measurements. (auth) (UK)

21889 DOPPLER BROADENING OF TWO-PHOTON POSITRON ANNIHILATION RADIATION. Reddy, K. Rama (Univ. of Illinois, Urbana); Carrigan, R. A. Jr. Contract AT(11-1)-1198. Nuovo Cim.; 66B: 105-19(11 Mar 1970).

Doppler broadenings of positron annihilation radiation were measured with a Li-drifted Ge-detector having a resolution of 1.76-keV FWHM for the 482-keV γ line of ^{181}Hf. From the observed shapes of the photopeaks of the annihilation radiation in various metals, the functional form of the momentum distribution of the annihilating pair has been obtained. The least-square analysis of the experimental curves gives values for the FWHM of the unfolded pair momentum distribution curves as 2.7 keV for Cu,

and 2.5 keV for Zn. These widths are consistent with angular correlation measurements on the annihilation quanta. Results obtained in the electric-field quenching in gaseous O_2 are presented. A double-subtraction method is presented and its utility is discussed in determining the Doppler broadening of the radiation originating from the positron annihilation with bound atomic electrons. A search for the one-photon ($E = (4/3)mc^2$) decay has been made. The upper limit for the relative cross section of the one-photon to two-photon free annihilation in potassium metal is $\leq 7.0 \times 10^{-6}$. The relative merits of Doppler broadening and conventional techniques are compared. (auth)

21890 MINIMUM OF THE ELECTRICAL RESISTANCE OF IRON, COPPER, LUTETIUM, AND THULIUM LAYERS OBTAINED BY LOW TEMPERATURE CONDENSATION. Kuz'menko, V. M.; Lazarev, B. G.; Sudovtsov, A. I.; Mel'nikov, V. I. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 58: 834-7(Feb 1970). (In Russian).

The temperature dependence of the electrical resistance of Fe, Cu, Lu and Tm layers obtained by deposition of the vapor of the metals on a backing cooled by liquid helium is studied. In all freshly deposited layers a minimum of electrical resistance is observed in the region of 4 to 25°K. The temperature of the minimum is found to depend on the thickness of the metal and on its degree of annealing. As a rule, high temperature annealing results in the disappearance of the resistance minimum in the thicker layers. It is suggested that a new singularity of conductivity electron scattering may exist in strongly distorted metallic lattices. (auth)

21891 A SIMPLE STRAIGHTFORWARD METHOD TO CALCULATE THE CORRELATION FACTOR AND ITS RELATION TO THE ISOTOPE EFFECT FOR IMPURITY DIFFUSION. Bakker, H. (Univ., Amsterdam). Phys. Status Solidi; 38: 167-76 (1 Mar 1970).

A general formalism is developed by which it is possible to relate the correlation factor to the isotope effect and to calculate the correlation factor for impurity diffusion by monovacancies in systems having at least a twofold symmetry around the vacancy-solute jump direction. However, the formalism can be extended to more complicated systems. Some well-known results are deduced easily from a general equation. The case of impurity diffusion in the two-dimensional hexagonal lattice and in the three-dimensional fcc lattice is worked out completely. (auth)

21892 THERMOELECTRON EMISSION, ELECTRIC CONDUCTIVITY, AND THERMOGRAVIMETRY IN STUDY OF POINT DEFECTS OF ZIRCONIUM OXIDE. Loup, J. P.; Anthony, A. M. (Centre de Recherches sur la Physique des Hautes Temperatures, Orleans, France). Phys. Status Solidi; 38: 499-512(1 Mar 1970). (In French).

The thermal emission of electrons from nonactivated zirconia is studied under oxygen pressure of 10^{-6} to 10^{-11} atm in the temperature range of 1650 to 1900°K. The network of isotherms shows two pressure ranges; under low pressure, the emitted current follows $p_{O_2}^{-1/6}$ and under higher pressure as $p_{O_2}^{-1/5}$. The "apparent activation energy" of the emission at a fixed pressure is very close in both domains. It is shown that the emission from the oxide is independent of its surface state but is related to the nature and concentration of point atomic defects present in the bulk of the solid. The anti-Frenkel disorder of singly charged oxygen ions is investigated; it makes possible a unique discussion of experimental results of emission, conductivity, number of transport, and thermogravimetry. (auth)

21893 A NOTE ON ANTIFERROMAGNETISM IN $UAs_{1-x}Se_x$. Leciejewicz, J.; Marasik, A.; Palewski, T.; Troc, R. (Swierk Research Establishment, Warsaw. Inst. of Low Temperatures and Structural Research, Wroclaw). Phys. Status Solidi; 38: K89-91(1 Mar 1970).

The stability range of the UAs antiferromagnetic phases was studied in $UAs_{1-x}Se_x$ for x = 0.04 to 0.21 by neutron diffraction using the magnetic peaks M(11½) and M(110). While two phases were observed for UAs (4.2–66°K and 66–127°K) and $UAs_{0.96}Se_{0.04}$, only the low-temperature phase was observed for $UAs_{0.9}Se_{0.1}$ and $UAs_{0.79}Se_{0.21}$. (D.L.C.)

Moessbauer Effects and NMR

Refer also to abstracts 20842 and 21011.

21894 SPIN RELAXATION PHENOMENA IN MOESSBAUER SPECTRA OF MAGNETICALLY ORDERED DYSPROSIUM INTERMETALLIC COMPOUNDS. Khurgin, B.; Nowik, I.; Rakavy, M.; Ofer, S. (Hebrew Univ., Jerusalem). J. Phys. Chem. Solids; 31: 49-54(Jan 1970).

Moessbauer studies of dysprosium metal and cubic Laves intermetallic compounds ($DyAl_2$, $DyNi_2$, and $DyCo_2$) were carried out at various temperatures in the range between 4.2° and 147°K. The measurements show that relaxation processes modify the Moessbauer spectra, especially at temperatures close to the Curie points. The rate equation method of relaxation theory was employed to interpret the observed experimental spectra. Assuming that the crystalline fields do not significantly modify the level structure of Dy^{3+} ions obtained due to exchange interactions, and considering only direct relaxation processes ($\Delta J_z = \pm 1$), fair agreement between theory and experiment is obtained. (auth) (UK)

21895 PROGRESS IN NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. VOLUME 4. Emsley, J. W.; Feeney, J.; Sutcliffe, L. H. (eds.). New York; Pergamon Press (1969). 471p.

Five reviews are presented on NMR of: organic charge-transfer complexes, organometallic exchange reactions, water in hydrate crystals, electrolyte solutions, and magnetic materials. A separate abstract was prepared for the review on magnetic materials. (D.L.C.)

For an abstract of one chapter see: 21896.

21896 NUCLEAR MAGNETIC RESONANCE IN MAGNETIC MATERIALS. Bose, Monisha (Saha Inst. of Nuclear Physics, Calcutta). Progr. Nucl. Magn. Resonance Spectrosc.; 4: 335-444(1969).

A review is presented of important recent developments and experimental data on NMR of magnetic materials. Paramagnetic materials, Knight shift in metals, magnetically ordered systems, quadrupole resonance in paramagnetics, acoustic nuclear spin resonance, and comparative evaluation of techniques for studying magnetic materials are discussed. 279 references. (D.L.C.)

21897 THE EFFECT OF UNRESOLVED QUADRUPOLE SPLITTING OF THE OBSERVED PEAK POSITION IN MOESSBAUER SPECTROSCOPY. Goodman, B. A.; Greenwood, N. N.; Turner, G. E. (Univ. of Newcastle upon Tyne, Eng.). Chem. Phys. Lett.; 5: 181-2(15 Mar 1970).

Unresolved quadrupole splitting can affect the peak position in Moessbauer spectra involving nuclear transitions other than those between $I = 1/2$ and $I = 3/2$. The magnitude of this effect was calculated for the $^3/_2$ to $^1/_2$ transition in ^{151}Eu and shown to be up to 0.5 mm sec^{-1}. (auth)

21898 ACOUSTIC MOESSBAUER EFFECT AND APPLICATIONS. Mishory, Jonathan. St. Louis; Washington Univ. (1969). 109p.

Thesis.

A simple mathematical analysis is presented for obtaining the frequency response of a composite acoustic resonator. It is pointed out that the most convenient variables in characterizing such an acoustic system are the specific impedances and the linear masses of the elements of the system. The technique is easily extended to more than one dimension and to any number of media. The theory of the acoustic Moessbauer effect is sketched. The calculation of the correlation function necessary for the development is carried out. It is shown how the introduction of the acoustic wave modifies the emission or absorption spectrum of the γ rays, both in frequency and intensity. An overall description of the experimental techniques employed is presented. Some experiments are described which attest to the validity of the theory, both for the frequency and intensity dependences predicted. Some applications of the acoustic Moessbauer effect are demonstrated. These applications pertain both to acoustic measurements and to the methodology of the Moessbauer effect. It is pointed out that the acoustic Moessbauer effect is most useful when thin acoustic samples, high attenuation, and the use of high frequencies preclude the use of conventional acoustic techniques. Applications of the sideband pattern generated when either source or absorber is acoustically excited are made to the calibration of conventional velocity drives and to construction of a variable frequency acoustic drive. The acoustic intensity dependence of the unshifted γ ray line is shown to be a convenient tool for measuring f fractions, especially in thick sources where the resonant self-absorption may be measured. (Diss. Abstr.)

Theory

21899 LATTICE DYNAMICS OF BERYLLIUM FROM A FIRST-PRINCIPLE PSEUDOPOTENTIAL APPROACH. King III, Walter Francis. University Park, Pa.; Pennsylvania State Univ. (1969). 93p.

Thesis.

The first-principle nonlocal pseudopotential theory developed by Harrison forms the basis for a discussion of the lattice dynamics of hcp metals. Within this framework and incorporating an effec-

tive potential for exchange among conduction electrons from Kohn and Sham, the characteristic function F (q) is constructed for beryllium. Expressions for the Coulombic and electronic components of the dynamical matrix are derived for noncubic lattices with a basis, which correct the equations given by Roy and Venkataraman. The dispersion relations calculated for phonons propagating in the [0001] and [01$\bar{1}$0] directions are in good agreement with the results of the neutron scattering experiments of Schmunk. Comparisons are also made with the theoretical beryllium spectra of Sahmi et al., and Kippel and Maradudin. The characteristic function is then used in a first-principle calculation of the three independent elastic shear constants. When these results are compared to the experimental values of Smith and Arbogast, good agreement is obtained for two of the constants and fair agreement for the third. (Diss. Abstr. Int., B)

Theoretical Physics

Refer also to abstracts 21827 and 21876.

21900 (FEI–159) ROTATIONAL ENERGY OF A TWO-PARTICLE SYSTEM. Gai, E. V. ([Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk]. Fiziko-Energeticheskii Institut). 1969. 21p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The energy of a quantum system is considered as a function of the angular momentum l for different potentials. Particular attention is given to the limit of the high rigidity of the potential. Specific examples are given to show the existence of a null rotational energy of the system, the relationship between the rigidity of the effective potential and the ratio of the excitation energy of a vibrational level to the excitation energy of a rotational level. A relationship is also shown between the dependence of the position of the minimum of the effective potential on l and the dependence of the rotational energy of the system on l. (JPRS)

21901 UNCERTAINTY RELATIONS IN QUANTUM MECHANICS. Prokhorov, L. V. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 29-35(Nov 1968). (In Russian).

The essence of uncertainties for the complementary variables appearing in the individual measurement is analyzed. It is shown that it is worthwhile to distinguish the inequality for the uncertainties relating to the individual measurement and for the mean characteristics of a wave packet (in full accordance with the situation in the case of energy and time). The possibility of the violation of the former inequality is discussed. (auth)

21902 ADIABATIC APPROXIMATION IN QUANTUM MECHANICS. Dubrovskii, G. V.; Pokrovskii, O. M. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 43-52(Nov 1968). (In Russian).

An asymptotic method is applied to solutions of the time-dependent Schroedinger equation in the adiabatic approximation. The general way of finding the "scattering matrix" is proposed for the case of the finite-dimensional representation of the Hamiltonian operator H(t) in the presence of the "intersections" of eigenvalues of H(t) in the complex plane of time. The results obtained can be used in the multichannel collision theory as well as in other problems of quantum mechanics. (auth)

21903 UNIFORM ASYMPTOTIC EXPANSIONS FOR THE SOLUTIONS OF THE SCHROEDINGER-TYPE EQUATION WITH TWO TRANSITION POINTS. I. Buldyrev, V. S.; Slavyanov, S. Yu. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 70-84(Nov 1968). (In Russian).

The principal term of the asymptotic expansions for the solutions of the Schroedinger equation with large parameter and two transition points were obtained by V. A. Fock and his coworkers. The construction of the subsequent terms based on the comparison equation method is shown. The first correcting term for the Bohr quantum condition is calculated. Bohr's formula was shown to hold with exponential approximation for some potentials. Special attention is devoted to the case of "close" transition points when asymptotic expansions for the eigenvalues are determined by the Taylor series for the potential at the characteristic point only. (auth)

21904 ELECTRON SPIN EQUATION IN AN EXTERNAL FIELD INVOLVING RADIATIVE EFFECTS. Baier, V. N.; Katkov, V. M.; Strakhovenko, V. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 31A: 198-9(23 Feb 1970).

High-energy electrons and positrons moving in a magnetic field can become polarized as a result of radiation. An equation is derived here describing the behavior of the electron spin in an external electromagnetic field that involves radiative effects. This equation enables one to examine the kinetics of radiative polarization. (TSS)

21905 QUASI-ENERGETIC SPECTRUM OF AN ELECTRON IN THE ELECTROMAGNETIC WAVE FIELD AND IN A HOMOGENEOUS MAGNETIC FIELD. Oleinik, V. P. (Kiev Inst. of Semiconductors). Ukr. Fiz. Zh.; 14: 2076-7(Dec 1969). (In Russian).

In a previous work the author showed that quasi-energetic electron spectra in an electromagnetic field and in a homogeneous magnetic field can be determined as an algebraic equation of the fourth order in relation to p_0 ($p_0 \equiv \epsilon_p$) and consequently results in the four-branch function $\epsilon_p = \epsilon_p(p_z)$ at fixed values of n and σ. Two branches of the function correspond to the electron states and the other two to positron. Moreover, the positron branches were obtained by inversion of electron branches in relation to the origin. An attempt was made of developing a clear graphical demonstration of the $\epsilon_p = \epsilon_p(p_z)$ function. (R.V.J.)

21906 THE EXCITATION OF SURFACE WAVES IN ANISOTROPIC MEDIA BY A CHARGED-PARTICLE BEAM. Abdel-Shahid, N. Z.; Pakhomov, V. I. (Atomic Energy Establishment, Cairo). Physica; 46: 87-96(23 Feb 1970).

The interaction of the potential surface waves occurring at the plane boundary of an arbitrary anisotropic medium with a charged-particle beam moving outside the medium parallel to the boundary and to the external magnetic field is investigated. The investigation is carried out on the basis of hydrodynamic theory. The general dispersion equation is derived by studying in detail the case of small-density beams and the case of high frequencies. The expressions for growth rates are obtained and the instability criteria are found. The case of the concrete medium (ionic semiconductor) is considered as an example. (auth)

21907 A REMARK ABOUT SUPERSELECTION RULES. Napiorkowski, K.; Woronowicz, S. (Univ. of Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 17: 579-80(1969).

Superselection rules are introduced in quantum field theory formulated by local Haag algebras using two postulates. Locality, translational invariance of the field, and spectrum condition are assumed. (M.H.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 21042.

21908 PROCEEDINGS OF BOULDER CONFERENCE ON HIGH ENERGY PHYSICS. A Special Meeting of the Division of Particles and Fields of the American Physical Society, Boulder, Colorado, August 18–22, 1969. Mahanthappa, K. T.; Walker, W. D.; Brittin, W. E. (eds.). Boulder, Colo.; Colorado Associated University Press (1970). 630p. (CONF-690813).

Twelve of the 14 invited talks and abstracts of 131 contributed papers are included in the Proceedings. Also included are summaries of some of the discussion sessions. Separate abstracts were prepared for NSA for the 12 papers. Two papers reprinted from Phys. Rev. Letters (23: 930 and 935(1969)) are included, which essentially contain the results of the invited talk on inelastic electron scattering. These two papers were previously abstracted for NSA, see 23: 51836 and 51837. The topics covered by the contributed papers include: photoproduction; electroproduction and vector meson dominance; electromagnetic theory; mesonic resonances; $\pi\pi$ and $K\pi$ phase shifts; mesonic resonances $S = \pm 1$; elastic scattering; baryonic resonances $S = -1, -2$; diffractive processes; quark models; current algebra; Veneziano model and duality; Regge theory and two-body processes; backward scattering; theory of high energy collisions; and weak interactions. (L.B.S.)

For abstracts of individual papers see: 21925, 21963–21965, 21973, 21974, 21978, 21987, 21988, 22000, 22020, and 22047.

Electromagnetic

Refer also to abstract 21019.

21909 (INSJ-113) POLARIZATION OF Λ-HYPERONS IN THE REACTION $\gamma p \rightarrow K^+ \Lambda$. Orito, Shuji (Tokyo Univ. (Japan). Inst. for Nuclear Study). 8 Dec 1969. 55p. Dep. CFSTI (U. S. Sales Only).

Thesis.

The polarization of the Λ hyperons in the reaction $\gamma p \rightarrow K^+ \Lambda$ was measured at the K^+ meson center-of-mass angles of about 45°, 70° and 90° and at the incident photon energies of 1054 MeV, 1100 MeV and 1160 MeV. The K^+ mesons were detected with a magnetic spectrometer and a velocity selection system. The polarization of the Λ hyperons was determined by measuring the up-down asymmetry of the protons in the decay $\Lambda \rightarrow p\pi^-$ with respect to the production plane. The obtained data show a dominant $\sin\theta_K^*$ dependence of the polarization at the region of the third resonance. A rise in the polarization at the forward θ_K^* has been observed at the incident photon energy of 1160 MeV. Based on the present measurements and the existing data, an energy-dependent multipole analysis of the reaction $\gamma p \rightarrow K^+ \Lambda$ was carried out at a mass range from 1610 MeV to 1870 MeV. The analysis strongly indicates a contribution of the resonance $P_{11}(\sim 1700)$. Without this resonance, it is difficult to fit the observed angular and energy dependences of the Λ-polarization. No clear evidence is obtained for the S_{11} resonance near 1700 MeV, leading to an upper limit of $\Gamma\gamma p \leq 9$ keV for the γp widths of $S_{11}(1710)$. As for the resonances $D_{15}(1680)$ and $F_{15}(1688)$, their contributions are found to be insignificant. (auth)

21910 (N-70-15166) AN EXPERIMENTAL INVESTIGATION OF FLUCTUATIONS AND CORRELATIONS IN ELECTROMAGNETIC AND NUCLEAR SHOWERS DEVELOPING IN LEAD. Brecht, Julius J. (Maryland Univ., College Park). 1969. 127p. (NASA-CR-107571; TR-955). CFSTI.

Thesis.

Electron showers at 105, 150, 300, 600, 1000, and 1200 MeV were studied using a Geiger tube hodoscope developed for balloon altitude observations of cosmic ray particles. The electron shower curves calculated from the experimental data are different from those obtained by other experimenters with various other detectors. Events obtained by exposing the detector to sea level cosmic ray mesons and to artificially accelerated protons and pions were treated in a manner identical to that used to analyze the electron data in hopes of detecting differences between electron showers and nuclear interacting events. Although some differences were found, the general characteristics of the nuclear interacting events were very similar to the electron showers. (auth)

21911 $\pi^\mp$ PHOTOPRODUCTION IN FORWARD DIRECTION. Ito, A.; Loe, R.; Loh, E. C.; Ramanauskas, A.; Ritchie, D.; Schmidt, W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 24: 687-90 (23 Mar 1970).

The ratio of π^- to π^+ off deuterium was measured as a function of incident photon energy from 600 to 1700 MeV in the forward direction. The ratio shows a broad dip around a center-of-mass energy of 1700 MeV, resulting presumably from the collective effect of several isospin-½ resonances in this energy region. Such a change in the ratio is reflected in the rapid variation of the isoscalar photoproduction amplitude since the isovector photoproduction amplitude was found to be a relatively smooth function decreasing slowly with increasing incident photon energy. (auth)

21912 DENSITY SPECTRUM OF PENETRATING COMPONENT OF EXTENSIVE AIR SHOWERS. Betev, B.; Stanev, T.; Valash, D. (Inst. of Physics, Sofia. Central Inst. for Physical Studies, Budapest). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1529-31(Sep 1969). (In Russian).

A hodoscopic installation consisting of four groups of Geiger–Mueller counters with a lead 30-cm thick absorber was used for determining the γ-spectrum density in the μ-meson component in extensive air showers. The measurements were carried out at an elevation of 2926 m above sea level. The results of 7104 events recorded showed that the degree of density is $\gamma = 2.27 \pm 0.08$. The distorting influence of multiplicity processes in the absorber were eliminated by corrections to the data. The obtained magnitude was found for EAS with the mean number of μ mesons equal to $\bar{n} \geq 1.2 \times 10^6$. (tr-auth)

21913 SERIES OF γ QUANTA AND SINGULARITIES OF PION GENERATION AT 10^{12} TO 10^{14} eV ENERGIES (THE ISOBAR GENERATION). Apanasenko, A. V.; Baradzei, L. T.; Smorodin, Yu. A.; Solov'ev, M. V. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1429-44(Sep 1969). (In Russian).

Characteristics of the process of generating pions in interactions with nucleons at 10^{12} to 10^{14} eV energies are investigated. The collection of spectral data confirms the conclusion that the pions appear during the decay of a cluster with 3 to 4 GeV mass, with a Lorentz-factor that is proportional to ϵ_0 and is close to the nucleon Lorentz factor following the interaction. It was postulated that the fast cluster forming with high probability of ~½ is an isobar. (tr-auth)

21914 THEORETICAL STUDIES OF FLUCTUATIONS IN EAS EVOLUTION. Karakula, Shch.; Kempa, Ya.; Vdovchik, E. (Inst. for Nuclear Research, Warsaw). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1495-7(Sep 1969). (In Russian).

An analysis of data obtained with EAS revealed a certain disagreement with shower parameters predicted with certain models. In order to coordinate the theoretical and experimental data, introduction of a much more rapid degradation of the energy of the nuclear-active EAS component is suggested. (tr-auth)

21915 HODOSCOPIC INSTALLATION FOR STUDYING FLUCTUATIONS OF μ-MESON FLUX IN EXTENSIVE AIR SHOWERS IN TYAN-SHAN STATION. Stamenov, I. N. (Lebedev Inst. of Physics, Moscow. Inst. of Physics, Sofia). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1518-28(Sep 1969). (In Russian).

A brief review is given on data on the spatial distribution of μ mesons and fluctuations of the number of muons in extensive air showers. The number of μ mesons as a function of the number of particles in the shower was analyzed. Descriptions are given of the Tyan-Shan installation including a hodoscopic system of counters with an effective area of 60 m^2 for studying fluctuations of number of muons, the dependence of the number of muons on the number of electrons, and also, for studying the μ-meson spatial distribution function behavior at small and medium distances from the shower axis. The counters were distributed under a ~20 m thick layer of ground, in a tunnel at 0 to 60 m from the center of the installation. The resolving power of the transistorized coincidence is 5 μsec. Data are recorded on a magnetic tape or photographically recorded. (tr-auth)

21916 SPECTRUM OF EXTENSIVE AIR SHOWERS ACCORDING TO THE NUMBER OF ELECTRONS AT MOUNTAIN LEVEL. Amineva, T. P.; Aseikin, V. S.; Glavach, T.; Nesterova, N. M.; Nikol'skii, S. I.; Romakhin, V. A.; Sokolovskii, V. I. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1508-17(Sep 1969). (In Russian).

Studies were made of wide atmospheric showers at an elevation of 3333 m above sea level. The spatial distribution of the electron-

photon component of the shower was investigated. The spectrum of the shower region with a small number of particles ($n \leq 10^4$) was obtained on the basis of the number of electrons in the investigated spectra of wide atmospheric showers. (tr-auth)

21917 BREMSSTRAHLUNG POLARIZATION MEASUREMENTS FOR 2-MeV ELECTRONS. Rank, D. (Oesterreichische Hochschule, Vienna). Z. Phys.; 233: 223-30(1970). (In German).

Linear polarization as a function of photon energy and emission angle was measured for bremsstrahlung from 2-MeV electrons incident on thin aluminum and gold targets. The polarimeter depends on the polarization sensitivity of the Compton process with a semiconductor detector as scatterer. The results show qualitative agreement with the Born approximation calculation of Gluckstern and Hull, although there is a quantitative difference for high-Z targets, which agrees with previous measurements of Motz for 1 MeV electrons. (auth)

Weak

21918 (COO-1195-171) SEARCH FOR DIRECT PROCESSES IN TWO PION RADIATIVE DECAYS OF POSITIVE AND NEGATIVE KAONS. Edwards, Ralph Thomas (Illinois Univ., Urbana). Feb 1970. Contract AT(11-1)-1195. 72p. Dep. CFSTI.

Thesis.

Decays of the type $K^{\pm} \to \pi^{\pm}\pi^0\gamma$ were observed in an experiment performed at Argonne National Laboratory using a scintillation counter–optical spark chamber arrangement, and a 3.5 BeV/c $K^{\pm}$ beam. These decays are interesting because the interference of two competing mechanisms for this decay may produce asymmetries in the partial decay rates for K^+ and K^- into this mode. The mechanisms are internal bremsstrahlung and a hypothetical direct process in which the gamma is produced within the decay vertex. The fraction of direct decays is consistent with zero, and the partial decay rate for direct decay, excluding interference between direct and internal bremsstrahlung amplitudes, is less than 10% (to 1 standard deviation) of the partial rate for internal bremsstrahlung for the kinetic energy of the charged pion between 58 and 90 MeV. The resulting upper limit for the asymmetries in the partial decay rates for $K^+ \to \pi^+\pi^0\gamma$ and $K^- \to \pi^-\pi^0\gamma$ is $[\Gamma(K^- \to \pi^-\pi^0\gamma)/\Gamma(K^+ \to \pi^+\pi^0\gamma)] - 1 = 0 \pm .24$ to one standard deviation for the same energy region. So, although the size of the direct process is small relative to internal bremsstrahlung, CP asymmetries have not been shown to be unobservable. (auth)

21919 (COO-1701-10) BETA DECAY OF THE LAMBDA HYPERON. Winston, Roland (Chicago Univ., Ill. Enrico Fermi Inst.). [nd]. 20p. (EFI-70-9; CONF-700102-3). Dep. CFSTI.

From Annual Meeting of the American Physical Society, Chicago, Ill.

Some preliminary results on $\Lambda \to p + e + \bar{\nu}$ decay are reported. At the completion of the data analysis, the ratio of axial-vector to vector amplitudes will be determined to < 0.1 and the relative phases to about 10°. Optical spark chambers and gas Cherenkov and scintillation counters are used for this study. (J.F.P.)

21920 (LAL-1226) MEASUREMENT OF THE PHASE φ_{00} IN RELATION TO THE AMPLITUDE OF DECAY OF K_L^0 AND K_S^0 IN THE $2\pi^0$ MODE. Chollet, J. (Paris Univ., Orsay (France). Faculte des Sciences). Dec 1969. 131p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The phase of the amplitudes of K_2^0 and K_1^0 in the $2\pi^0$ decay mode is investigated using a K_2^0 beam in a block of copper. In this way K_1^0 is produced coherently with the incident K_2^0. These two mesons can decay in the same state, which produces an interference term in the production intensity of the $2\pi^0$. This allows a measurement of the phase φ_{00} to be made. Spark chambers were used in this study. The phase was found to be $21 \pm 30°$. (J.F.P.)

21921 ENERGY MEASUREMENT OF MUONS ABOVE 1 TeV. Moe, M. K. (Univ. of California, Irvine). Nuovo Cim.; 66B: 90-6(11 Mar 1970).

Pair production and bremsstrahlung cross sections have sufficient magnitude and energy-dependence for muons above 1 TeV to suggest the use of these cross sections for measurement of muon energies. A series of Monte Carlo calculations was developed to examine the precision of energy measurement attainable for individual muons when bursts produced in a large thickness of lead are sampled by interleaved proportional or scintillation counters. Resolution of ±21% can be expected for 3-TeV muons passing through $2.8 \cdot 10^4$ g/cm² of lead if all burst energies greater than 1 GeV are sampled with ±30% resolution. The muon energy resolution becomes ±25% if the detectable burst threshold is raised to 8 GeV. It is reasonable to expect that the sampling quality for the latter case could be accomplished with counters spaced every few radiation lengths in the lead. (auth)

21922 EXPERIMENTAL RESULTS ON THE PION AND NEUTRON PRODUCTION BY MUONS AT 60 AND 110 m w.e. Bergamasco, L. (CNR, Turin. Univ., Turin). Nuovo Cim.; 66B: 120-8(11 Mar 1970).

Some results are presented on the stopping-pion rate in liquid scintillator and on the evaporation neutrons produced in lead by the interactions of fast muons at the depths of 60 and 110 m w.e. These results are satisfactorily compared with the predictions on the muon-nucleon inelastic scattering based on the vector dominance approach. (auth)

21923 SEARCH FOR THE NEUTRINO IN MUSCOVITE MICA. Wolfendale, A. W.; Craig, R.; Mamidzhanyan, E. A. (Univ. of Durham, Eng. Erevan State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1560-2(Sep 1969). (In Russian).

It was postulated previously that certain tracks in muscovite mica are induced by charged particles. An analysis of available data showed that the suggested hypothesis is not sufficiently substantiated. (tr-auth)

21924 FORM FACTORS IN THE DECAY $K^+ \to \pi^0 + l^+ + \nu$. Botterill, D. R.; Brown, R. M.; Clegg, A. B.; (and others) (Nuclear Physics Lab., Oxford). Phys. Lett.; 31B: 325-8(2 Mar 1970).

The π^0 energy spectrum in K_{e3}^+ decay was measured. Assuming the vector interaction alone it is found that the momentum dependence of the form factor f_+ is given by $\lambda^+ = 0.045 \pm 0.015$. Using this value of λ^+ and assuming $\lambda^- = 0$, the $K_{\mu 3}^+$ data give $\xi(0) = f_-(0)/f_+(0) = -0.35 \pm 0.22$ for the ratio of the form factors. (auth)

21925 RECENT RESULTS FROM UNDERGROUND COSMIC RAY EXPERIMENTS. Larson, M. O. (Univ. of Utah, Salt Lake City). pp 278-88 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

The results of data gathered using the full Utah Detector are reported. The ⅔ kiloton Utah Detector consists of four water-filled Čerenkov tanks, 600 cylindrical audio spark counters, and two 15.5-kgauss solid-iron magnets. Five papers dealing with the following topics are reviewed: zenith-angle distribution of ultra-high-energy muons; the charge ratio of ultra-high-energy muons; search for anisotropies in the underground muon flux; the lateral distribution of muon showers deep underground; and high-energy neutrinos in the Utah apparatus. (L.B.S.)

21926 INVESTIGATION ON CONSERVATION OF μ-LEPTON NUMBER. Borer, K.; Hahn, B.; Hofer, H.; Kaspar, H.; Krienen, F.; Seiler, P.-G. (CERN, Bern). Helva. Phys. Acta; 43: 111-32 (Apr 1970). (In German).

An investigation was made on the conservation of the muonic lepton number by using a pure neutrino beam and by measuring the charge ratio of the muons in neutrino interactions. The experiment yields a new upper limit for a possible violation of the muonic lepton number of $<3.8(10)^{-3}$ (90% confidence) expressed in the μ^+ to μ^- ratio. (auth)

Strong (Baryon-Induced)

21927 PROTON–PROTON ELASTIC SCATTERING AT 15, 20, AND 30 BeV/c. Carrigan, R. A. Jr. (Carnegie-Mellon Univ., Pittsburgh); Edelstein, R. M.; Hien, N. C.; (and others). Phys. Rev. Lett.; 24: 683-6(23 Mar 1970).

Proton-proton elastic scattering was measured at 15.2, 20.0, and 29.7 BeV/c. The data at 20.0 BeV/c confirm the presence of a break at $-t \cong 1.2$ (BeV/c)². The data at 29.7 BeV/c show essentially the same behavior. The cross section is still falling with increasing energy in this $-t$ range. (auth)

21928 CHARACTERISTICS OF PION AND NUCLEON INTERACTIONS WITH VARIOUS NUCLEI. Murzin, V. S.; Sarycheva, L. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1454-60(Sep 1969). (In Russian).

Ionization calorimeters and a Wilson chamber were used in studies of pion and nucleon interactions with nuclei at 200 GeV energy. Correlations of characteristics of charged and neutral particles offer statistical data on the peculiarities of pion interactions. It was found that a considerable number of particle collisions was asymmetrical in the pion-nucleon system and symmetrical in the system of incident pion and virtual pion-target (pion-pion collisions). Nucleon interactions usually are symmetrical in the center-system of two nucleons. (tr-auth)

21929 MULTIPLICITY DISTRIBUTIONS OF PION–NUCLEON AND NUCLEON–NUCLEON INTERACTIONS AT HIGH ENERGIES. Bozoki, D.; Gomboshi, E.; Posh, M.; Vanichek, L. Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1445-53(Sep 1969). (In Russian).

Experimental distributions of multiple-charged particles in pion-nucleon and nucleon-nucleon interactions at energies above 1 GeV were analyzed. It was found that the distribution can be easily approximated by means of a simple function. The parameters of the function depend on the energy, multiplicity, and the ratio of cross sections of charged particle formation in inelastic reactions. The obtained relations of cross sections of formation of n charged secondary particles in the πN and NN interactions and also the relation of the mean multiplicity in the πN and NN interactions are discussed. (tr-auth)

21930 PROCESS OF FIREBALL FORMATION DURING QUASI NUCLEON INTERACTIONS OF PROTONS AT ENERGIES OF 20 TO 23 GeV. Zhdanov, G. B.; Tret'yakova, M. I.; Chernyavskii, M. M. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1417-28(Sep 1969). (In Russian).

Heavy boson resonances and fireballs were found by means of a new method based on the ratio of effective mass of meson systems including or not including secondary protons. The method was also used in the analysis of quasi-nucleon nuclear interactions of protons (photoemulsion in a pulsed magnetic field of 180 kV) with the multiplicity of n = 5 to 8. The selected events are described by mean mass of the meson cluster 3.0 ± 0.2 GeV/c^2, considerable transverse and longitudinal momenta in the center of inertia system, anisotropic (in the cluster system) distribution of zenith and azimuthal angles, and other properties which are in agreement with the model of fireball formation suggested by V. N. Akimov et al. (Preprint No. 134, Phys. Inst. of the USSR Acad. of Sciences, 1968). Experimental evaluation of the cross section of the process is nearly 5 mbarn. (tr-auth)

21931 CHARACTERISTICS OF INELASTIC NUCLEAR INTERACTIONS OF COSMIC-RAY PARTICLES AT 10^{11} TO 10^{13} eV. Guseva, V. V.; Denisov, E. V.; Dobrotin, N. A.; Zelevinskaya, N. G.; Kotel'nikov, K. A.; Lebedev, A. M.; Maksimenko, V. M.; Morozov, A. E.; Slavatinskii, S. A. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1408-13(Sep 1969). (In Russian).

The Tyan-Shan installation, consisting of Wilson cloud chamber in a magnetic field and ionization calorimeter, was used for measuring the mean free path of nuclear shower absorption in iron and the cross sections of inelastic interactions of neutrons in iron and all nuclear-active particles at 200 to 1500 GeV energies. A considerable imbalance of meson longitudinal momentum in (cms) was observed in ~⅓ cases in the showers generated in the LiH targets. The distribution of the asymmetry parameters was wider than anticipated considering the error of measurements and fluctuations in the angle of separation of charged and neutral mesons. (tr-auth)

21932 EXTENSIVE AIR SHOWERS AND INTERACTIONS OF HIGH-ENERGY PARTICLES. Nikol'skii, S. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1501-7(Sep 1969). (In Russian).

It is shown that experimental data obtained on inelastic interactions between nuclei and nucleons at 10^{13} to 10^{14} eV should be taken into account in interpretations of wide atmospheric showers, induced by particles of the primary ultra-high energy cosmic radiation. Data obtained with the Tyan-Shan complex installation revealed variations in the characteristics of nuclear interactions at the nucleon energies examined. The problem of the wide multicore shower related to the properties of the incident particle inducing showers and to the large transverse momenta of the secondary particles in the events of inelastic collisions at ultra-high energies was discussed. (tr-auth)

21933 ENERGY SPECTRA OF COSMIC-RAY NEUTRONS AT SEA LEVEL. Ashton, F.; King, Dzh.; Mamidzhanyan, E. A.; Smitt, N. L. (Univ. of Durham, Eng. Erevan State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1557-9(Sep 1969). (In Russian).

Preliminary data obtained during ~600 hr of operation showed that the differential energy spectrum of neutrons in the range from 500 to 1000 GeV may be described by $N(E)dE = AE^{-\gamma}dE$ where A = const and $\gamma = 2.96 \pm 0.10$. An analysis was made of neutron distribution and the magnitude of neutron absorption track in the atmosphere was determined to equal 118 ± 16 g cm^{-2}. (tr-auth)

21934 PRODUCTION OF HYPERNUCLEI BY THE ABSORPTION OF Σ^- HYPERONS AT REST IN EMULSION NUCLEI. Bohm, G. (Institut fuer Physik Hoher Energien, Berlin); Wysotzki, F.; Cseithey-Barth, M.; (and others). Acta Phys. Pol.; A37: 135-42(Jan 1970).

The production of hypernuclei by the interactions at rest of Σ^- hyperons was studied in emulsion. The rates of trapping of Λ^0 hyperons following absorptions in both heavy (Ag,Br) and light (C,N,O) nuclei were estimated. These are compared with the corresponding rates found for K^- meson captures. An analysis of the production reactions proved to be of little help in the assignment of hypernuclear identities. (auth)

Strong (Meson-Induced)

Refer also to abstracts 21018, 21928, 21929, and 21944.

21935 (COO–1195-175) K-PLUS PROTON ELASTIC SCATTERING AT 2.53, 2.76 AND 3.20 GeV/c. Whitmore, James Jonathan (Illinois Univ., Urbana). Feb 1970. Contract AT(11-1)-1195. 137p. Dep. CFSTI.

Thesis.

The results of a study of K^+p elastic scattering at incident kaon momenta of 2.53, 2.76, and 3.20 GeV/c are presented. The data were obtained from exposures of the MURA 30″ hydrogen bubble chamber at the Argonne National Laboratory, Illinois. Differential and total elastic cross sections are given. Characterizing the kaon center-of-mass angular distributions are peaks in both forward and backward directions. The momentum dependence of both the diffraction and backward peaks in K^+p elastic scattering is compared with the calculations of Regge pole exchange models. Also presented are some preliminary results of a phase shift analysis at 2.50 GeV/c. (auth)

21936 (COO-1195-179) MESON AND BARYON PRODUCTION IN THE REACTION $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ AT 4.19 GeV/c. Gordon, Howard Allan (Illinois Univ., Urbana). Feb. 1970. Contract AT(11-1)-1195. 124p. Dep. CFSTI.

Thesis.

A study of 1809 events of the reaction $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ at 4.19 GeV/c incident pion momentum is reported. The experiment was done in the Lawrence Radiation Laboratory 72 in. deuterium bubble chamber. A significant amount of beam contamination is found but shown not to be present in the events selected for analysis. A considerable amount of ρ production is found. The clearest feature of the data is the ω^0 production with a cross section of $\sigma(\pi^+n \rightarrow \omega^0p) = 0.36 \pm 0.05$ mb. There is a 2-standard deviation dip in ρ_{00} for the ω^0 between $0.2 < |t| < 0.3$(GeV/c)^2 and a small negative value of $Re\rho_{10}$ for $|t| < 1.0$(GeV/c)^2. The dip in ρ_{00} is consistent with the vanishing, in that region of t, of an exchanged trajectory with unnatural parity. A simple Regge model calculation with ρ + B exchange does not reproduce the data. Evidence is given for simultaneous $\rho\Delta(1236)$ production produced by one-pion exchange. Enhancements are seen in the three pion spectrum corresponding to the A_1, A_2 and $\varphi(1650)$. The data alone cannot prove that the I = 0 assignment for the φ is correct. (auth)

21937 (NP-tr-1877) CHANNELS OF THE REACTION $\pi^-p \rightarrow n\pi^+\pi^-m\pi^0$ AT pc = 4 GeV. Grishin, V. G.; Iresh, M.; Kopylova, D. K.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR-P1-4412. 18p. Dep. CFSTI (U.S. Sales Only).

This item was previously abstracted from the original language and appeared in NSA as 23: 34533. (J.F.P.)

21938 (TID-25359) PROGRESS REPORT [ON HIGH-ENERGY PHYSICS, MARCH 1970]. Bugg, W. M.; Condo, G. T.; Hart, E. L. (Tennessee Univ., Knoxville). Contract AT(40-1)-3956. 5p. Dep. CFSTI.

A summary of research is presented on meson (π^+) interactions with deuterium and slow meson (K^-) and hyperon (Σ^-) capture by neon nuclei. A list of publications issued during this period is appended. (J.F.P.)

21939 DIFFRACTION GENERATION OF π MESONS BY NUCLEONS AND π MESONS ON COMPLEX NUCLEI. Azimov, S. A.; Abduzhamilov, Sh.; Beter, E. V.; Gulyamov, U. G.; Chudakov, V. M. (Physical-Technical Inst., Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1402-7(Sep 1969). (In Russian).

Problems related to diffraction production of π mesons by nucleons and pions on complex nuclei are discussed. Results of the analysis made of proton interactions at $p_0 = 25$ GeV/c in a stack of emulsions and of π^- mesons at $p_0 = 17.2$ GeV/c are discussed. The transverse-momentum distribution of secondary particles was in agreement with theoretical curves obtained with the assumption of diffraction production of pions. (R.V.J.)

21940 STUDIES OF HIGH-ENERGY PARTICLES IN PROTON COSMIC STATIONS. Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1469-81(Sep 1969). (In Russian).

Spectra of primary cosmic ray particles (ionization bursts) were measured at energies up to 10^{14} eV and proton spectra at energies up to 10^{13} eV. Effective cross sections of inelastic proton interactions with carbon nuclei in energy range from 2×10^{10} to 6×10^{11} eV and with protons in the same energy range measured by the Proton satellite are discussed. (tr-auth)

21941 SEARCH FOR pi^-p^- RESONANCES PRODUCED IN 7 GeV/c pi^-d INTERACTIONS. Katz, W. M.; Ferbel, T.; Slattery, P. F.; Yuta, H. (Univ. of Rochester, N. Y.). Phys. Lett.; 31B: 329-32(2 Mar 1970).

A search was carried out for resonances in the $\pi^-\rho^-$ system produced in the reaction $\pi^-d \rightarrow pp\pi^-\rho^-$; we observe no significant structure in the $\pi^-\rho^-$ mass spectrum, and place an upper limit of 6μb for resonance production in this channel. (auth)

21942 K^-n ELASTIC SCATTERING AT 3 GeV/c. Giacomelli, G. (Istituto Nazionale di Fisica Nucleare, Bologna); Rimondi, F.; Rossi, A. M.; (and others). Phys. Lett.; 31B: 321-4 (2 Mar 1970).

The $K^-n \rightarrow K^-n$ elastic scattering angular distribution was measured at the laboratory momentum of 3 GeV/c in a deuterium bubble chamber. Using previously measured $K^-p \rightarrow K^-p$ and $K^-p \rightarrow \overline{K}^0n$ data at the same energy, the elastic differential cross sections for production of definite isospin states were computed. (auth)

21943 PRODUCTION OF $\Sigma^\pm$ MULTI-BODY FINAL STATES ($\geq$ FOUR BODIES) IN 4.25 GeV/c K^-p INTERACTIONS. Einschlag, Michael Barry. College Park, Md.; Univ. of Maryland (1969). 225p.

Thesis.

Observations are described on events from 53,000 photographs taken at the Brookhaven National Laboratory 80" hydrogen bubble chamber exposed to a beam of 4.25 GeV/c K^- mesons. The events consist of 4 or 6 charged prongs emanating from a production vertex with the subsequent appearance of one or more kinks in the prongs. The kink is required to indicate the presence of a charged sigma hyperon. Cross sections are presented for all final states consistent with the above criteria. More detailed analysis is undertaken of the final states. (1) $K^-p \rightarrow \Sigma^\mp\pi^\pm\pi^+\pi^-$ (2) $K^-p \rightarrow \Sigma^\mp\pi^\pm\pi^+\pi^-\pi^0$. The analysis is divided into four major categories: maximum likelihood analysis of the invariant mass spectra of the above final states; investigation of the properties of quasi-two body production; search for existence of a double Regge exchange mechanism in quasi-three body production; application of a phenomenological multi-Regge exchange model to the multi particle final state. The likelihood analysis finds the need to introduce three body resonances (containing a baryon) in the mass range 1900 $\rightarrow$ 2500 MeV in order to properly fit the three body spectra in final states 1 and 2. These resonances, however, occur over large backgrounds and are largely inseparable from them. Although quasi-two body production is suppressed compared to quasi-three body production it is still possible to separate out several clean quasi-two body final states such as $Y_\delta^\pm\rho$, $Y_\delta^\pm\omega^0$, $Y_\delta^\pm 1660\,\pi^-$ ($Y_\delta^\pm$ means $Y_\delta^\pm 1405$, $Y_\delta^\pm 1520$ etc). Little evidence is present for the existence of a double Regge exchange mechanism in these data, but reasonable agreement is found with the prediction of the phenomenological multi-Regge exchange model with respect to the single particle center of mass distributions. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 21908.

21944 (COO-1810-4) PROGRESS REPORT ON PARTICLE PHYSICS. (Michigan State Univ., East Lansing). [1965]. 5p. Dep. CFSTI.

Research on particle interactions at the University of Michigan during 1965 is described. This research includes the random phase approximation methods for quantum field theory, quark models for the electromagnetic mass splitting for hadrons, and pion scattering from nuclei. (J.F.P.)

21945 (JINR-P2-4914) PHASE-SPACE VOLUME OF ANGULAR CORRELATIONS FOR THE REACTION A + B $\rightarrow$ C + D + E FOR THE CASE OF ARBITRARY PARTICLE MASSES. Suslenko, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 6p. (In Russian). Dep. CFSTI.

The phase-space relativistic expressions for angular correlations of particles in the final state of the reaction A + B $\rightarrow$ C + D + E were derived for the case of arbitrary masses of particles involved in the given reaction. (auth)

21946 SUM RULES OF THE DISPERSION METHOD. Barth, Alfred (Univ., Tuebingen, Ger.). Fortschr. Phys., 17: 205-33 (1969). (In German).

A survey is made of the sum rules in elementary particle physics, which were obtained with the dispersion technique. After a discussion of the high energy behavior, the superconvergent type is first considered. Here the equations for the annihilation channel are of special interest since they give relations between pure meson and meson-baryon coupling constants. Some examples for the dispersion sum are given. The general formalism for the derivation of the different sum rules from the current algebra are shown within the framework of the dispersion technique. By suitable limits the superconvergence relations were maintained so that the circle of these considerations was closed. In the selection of the individual examples no completeness could be claimed. They were often selected as being the most pragmatic. Some technical details were compiled. (tr-auth)

21947 EQUAL-TIME COMMUTATORS, FIXED POINT THEOREMS, SUPERCONVERGENCY, AND PCAC IN THE LEE MODEL. Tadic, D.; Zovko, N. (Inst. Rudjer Boskovic, Zagreb. Univ., Zagreb). Z. Phys.; 233: 398-414(1970).

It is shown that some properties characteristic of the real physical theories can be illustrated in the standard Lee model, in particular fixed point theorems and superconvergency. The problem of equal time commutator was also discussed. All "physical" results, both for the smeared and for the point source model depend on well defined and calculable quantities, the high energy behavior of the scattering amplitude being in agreement with Bjorken's theorem. There is a particular "relativistic" generalization of the model which allows for PCAC. (auth)

Electromagnetic

Refer also to abstracts 22003 and 22008.

21948 (COO-264-538) $\rho\omega$ MIXING: THE MIXING FORMALISM AND PHENOMENOLOGICAL THEORIES. Willemsen, Jorge F. (Chicago Univ., Ill.). Feb. 1970. Contract AT(11-1)-264. 31p. (EFI-70-11). Dep. CFSTI.

Previously undiscussed details of a general propagator mixing formalism for vector mesons, including consideration of both mass and kinetic terms, are presented. Specifically, it is shown how dynamic self-energy effects contribute to the kinetic terms, leaving the mass matrix real; the mixing problem is solved in the case of constant matrices; and a Bell-Steinberger type unitarity relation appropriate for vector mesons is displayed. Further, it is shown that the near degeneracy of ρ and ω mesons makes it very difficult to distinguish between mass-mixing and current-mixing phenomenological parameters, but that a small and perhaps detectable difference for the magnitude of these parameters is predicted by the respective models in a Coleman-Glashow symmetry breaking scheme. The significance of the difference is discussed. (auth)

21949 (COO-264-540) PCAC, THE DALITZ PAIR PROCESS AND THE "PRIMAKOFF EFFECT" IN THE PHOTOPRODUCTION OF A_1^0 ON PROTON. Chang, T. H. (Chicago Univ., Ill., Enrico Fermi Inst., Chicago Univ., Ill. Dept. of Physics). Mar 1970. Contract AT(11-1)-264. 44p. (EFI-70-14). Dep. CFSTI.

Thesis.

PCAC is introduced into the Dalitz pair process and then its consequence is compared with the ordinary quantum electrodynamical approach and Adler's perturbation method in which the triangular diagram is essential for the $\pi^0\gamma\gamma$ vertex. The Primakoff effect in the photoproduction of the axial-vector meson A_1^0 on proton is calculated explicitly. The coupling strength of the $A_1^0\gamma\gamma$ vertex is determined from the hyperfine splitting in the hydrogen atom, which is ten times smaller than determined from the $\pi^0\gamma\gamma$ vertex indirectly. (auth)

21950 (FOA-4-4374) A USER'S MANUAL FOR A COMPUTER CODE CALCULATING DENSITIES AND VELOCITIES OF COMPTON ELECTRONS GENERATED BY GAMMAS. Engstroem, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct 1968. 14p. Dep. CFSTI (U. S. Sales Only).

A Monte Carlo code is described which treats the transport of gamma radiation in spherical geometry and calculates various data for the Compton electrons generated by the photons such as production densities, average radial velocities and radial current. The quantities are differentiated in time. (auth)

21951 (IAE-1856) DIRAC MONOPOLE. Barkov, L. M.; Martem'yanov, V. P.; Orurtsov, V. V.; Tarasenkov, V. G.; Khakimov, S. Kh. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi

Energii). 1969. 32p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The basic properties of the Dirac monopole and experiments seeking monopoles on high energy accelerators are discussed. (auth)

21952 (ITF-70-1) PHOTOPRODUCTION OF NEUTRAL PSEUDOSCALAR MESONS IN MODEL TAKING INTO ACCOUNT POLES, CUTS AND CONSEQUENCES OF HIGH SYMMETRIES. Kobylinskii, N. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 17p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A theoretical model is considered founded on taking into account the contributions of ρ and ω Regge poles and cuts, corresponding to simultaneous exchange in t-channel by one of these poles and vacuum pole. Use of SU(3)-symmetry, vector dominance model and quark model essentially decreases the number of parameters which, in turn, allows one to obtain a number of simple relations between asymmetries, differential cross sections of meson production by polarized and unpolarized photons and polarizations of recoil nucleons for the processes of photoproduction of π and η-mesons on protons and neutrons at high energies and small momentum transfer. The obtained relations agree with the present experimental data. The importance is noted of measuring polarization of recoil nucleons and asymmetries of angular distributions of mesons to verify the assumptions in the foundation of a considered model. (auth)

21953 (ITF-70-2) PHOTOPRODUCTION OF η-MESONS ON NUCLEONS AT HIGH ENERGIES. Kobylinskii, N. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 12p. (In Russian). Dep. CFSTI (U.S. Sales Only).

Processes of photoproduction of η-mesons on nucleons at high energies are considered within the frameworks of a model taking into account ρ and ω poles and ρP and ωP cuts. Pole residues and cut discontinuities for the amplitude of η-meson production are connected with those for π-meson production by SU(6)-symmetry and vector dominance model. The model allows one to describe present experimental data and to make a number of predictions. (auth)

21954 (LAL-1196) RECOIL PROTONS FROM WIDE ANGLE BREMSSTRAHLUNG. Allton, E. A. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire. Daresbury Nuclear Physics Lab. (England)); Erickson, E. F. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire. Strasbourg Univ. (France). Institut de Recherches Nucléaires). May 1969. 28p. Dep. CFSTI (U. S. Sales Only).

The momentum spectrum of the recoil protons produced in a liquid hydrogen target by an electron beam is studied. The contribution of wide-angle bremsstrahlung is considered and the differential cross section for this process is obtained by integrating the Bethe-Heitler terms of the BL matrix element over the phase space of the unobserved (final electron, photon) system. When the electron rest mass is neglected, the formula obtained is the sum of two terms, the dominant one being of logarithmic order. It is then similar to that obtained for the process in which the incoming electron radiates a photon backward in a physical radiator and then scatters elastically on a proton, which, in turn, recoils into the detector. (auth)

21955 (UR-875-295) COULOMB PRODUCTION OF N*(1236). Nagashima, Y.; Rosen, J. L. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 3 Nov 1969. Contract AT(30-1)-875. 17p. Dep. CFSTI.

The cross section for $N + \gamma_C \rightarrow N^*$ in the Coulomb field of a nucleus is calculated. This process may provide the basis for a new scheme for high energy neutron detection with excellent energy and directional properties. The cross section is directly related to the well established process of N^* photoproduction $\gamma + N \rightarrow N^*$ so that the absolute efficiency of the neutron detection scheme may be predicted with some reliability. The possibility of constructing a tagged neutron or antineutron beam is also briefly discussed. (auth)

21956 GRAPHICAL APPROXIMATION OF THE MOLIERE THEORY FOR MULTIPLE ELECTRON SCATTERING AT ENERGIES OVER 1 MeV. Pomanskii, A. A. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1581-2(Sep 1969). (In Russian).

Multiple electron scattering formulas show that it is possible to unify the theory of multiple scattering by expressing the thickness of the scatterer in fractions of radiation lengths. In such a case the distribution of electrons crossing the plate of any material could be represented as one graph. (tr-auth)

21957 CORRELATION OF THEORETICAL AND EXPERIMENTAL CASCADE CURVES FOR HEAVY SUBSTANCES. Samosudov, B. E. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1573-5(Sep 1969). (In Russian).

Correlation of theoretical and experimental cascade curves for heavy absorbers results sometimes in quite unexpected discrepancies. Sometimes the experimental data obtained in track-type installations are considerably lower than the theoretical data on cascade particle distribution with depth. Corrections made considering Coulomb scattering and inverse current of cascade particles often eliminate the discrepancies between the theoretical and experimental data. (tr-auth)

21958 USE OF THE MOMENTS METHOD FOR RESOLVING SPACE-ANGLE PROBLEM IN CASCADE THEORY. Guzhavin, V. V.; Osipova, L. N. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1570-2(Sep 1969). (In Russian).

Spatial moments of shower electron and photon distribution functions according to their angles and distances from the axis in cascade showers were calculated with the approximation of small angles of multiple scattering. Data were obtained for zero spatial moments of electron distribution functions for various cascade parameters s. (tr-auth)

21959 SPATIAL DISTRIBUTION OF PARTICLES OF CASCADE SHOWER IN THE ATMOSPHERE. Guzhavin, V. V.; Ivanenko, I. P.; Paskhalov, Yu. I. (Radio-Technical Inst., Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1567-9(Sep 1969). (In Russian).

Studies were made of the spatial distribution of particles in cascade showers in the atmosphere. Integro-differential equations, describing development of the electron-photon shower were obtained taking into account the losses from ionization of the media. Functional transformations and the method of moments were used for developing recurrent differential correlations which permitted the analytical determination of transform functions of angular and spatial distribution of shower electrons and photons at $\beta = 0$. A function for spatial and angular distribution of electrons was constructed according to the two initial moments at the depth of $s = 1$ and $E_0/E \approx 5 \times 10^2$. The difference between the obtained function and a similar function for the homogeneous media was ~20%. (tr-auth)

21960 ANGULAR DISTRIBUTION OF EXCESS OF ELECTRONS IN CASCADE SHOWERS. Guzhavin, V. V.; Ivanenko, I. P. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1563-6(Sep 1969). (In Russian).

Variable angular distributions of high-energy electrons and positrons in electron-photon cascade showers in air were studied. It is shown that in the case in which the distribution of shower particles was determined only by their Coulomb scattering, the angular distribution of electron saturation at large angle proved to be flatter than the angular distribution of the sum of electron and positrons. (tr-auth)

21961 ESTIMATION OF THE MEAN TRANSVERSE MOMENTUM IN EAS MEASUREMENTS. Giler, M.; Vdovchik, E. (Inst. for Nuclear Research, Warsaw). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1498-1500(Sep 1969). (In Russian).

Calculations were made of muon spatial distribution functions for a model with a higher multiplicity for secondary particles than the assumed $n_s \sim E^{1/4}$ and for the primary nuclei with $A > 1$. In order to coordinate the theoretical and experimental data it was assumed that the mean transverse momentum of secondary particles is larger than 0.4 GeV/c. (tr-auth)

21962 CROSS SECTION FOR ELECTRON-DEUTERON ELASTIC SCATTERING AT VERY LARGE MOMENTUM TRANSFER. Chylinski, Z. (Inst. of Nuclear Research, Krakow). Acta Phys. Pol.; A37: 97-119(Jan 1970).

The cross section of electron-deuteron elastic scattering is evaluated at very large momentum transfer, assuming that the internal nonrelativistic wave function of the deuteron is an absolute, i.e., independent of the Lorentz frames of reference, characteristic of the deuteron. This assumption is a consequence of the geometrical hypothesis — called the phase geometry — which is briefly presented. (auth)

21963 HIGH ENERGY PHOTOPRODUCTION. Diebold, R. (Argonne National Lab., Ill. Stanford Univ., Calif.). pp 3-92 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

A general review is given of the experimental data on photoproduction at energies above 2 or 3 GeV. The topics discussed include total photon cross sections, vector meson production,

photoproduction of pseudoscalar mesons, multibody final states, and reactions off complex nuclei. (L.B.S.)

21964 THEORETICAL IDEAS ON INELASTIC ELECTRON–NUCLEON SCATTERING. Paschos, Emmanuel A. (Stanford Univ., Calif. Rockefeller Univ., New York). Contract AF49(638)-1545. pp 103-34 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

The study of the structure of the proton from inelastic electron-proton scattering at high energies and large momentum transfers is reviewed. The fundamental contributions of Bjorken and Feynman are first reviewed. Several models are then discussed; these include the parton model, field theoretical model, diffraction models, and vector meson dominance. It is pointed out that the underlying structure of the parton model can be used to describe the asymptotic limits for several of the models. The consequences of the data and of the models are discussed for other processes, such as inelastic neutrino scattering, neutron-proton mass differences, and inelastic Compton scattering. (L.B.S.)

21965 THEORY OF WEAK INTERACTIONS. Wolfenstein, L. (Carnegie Inst. of Tech., Pittsburgh). pp 164-81 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

The formulation of the theory of weak interactions and some of the predictions of the theory for purely leptonic processes, semileptonic processes, and nonleptonic processes are reviewed. (L.B.S.)

21966 MASS DIFFERENCE BETWEEN THE $\pi^{\pm}$ AND THE π^0, USING A BETHE–SALPETER EQUATION. Patergnani, G. (Univ., Padua). Z. Phys.; 233: 216-22(1970).

Previously a bound state of a nucleon-antinucleon pair was studied with a Bethe–Salpeter equation in the ladder approximation. The electromagnetic interaction is used to produce in the bound state the difference of mass $\Delta\mu$ between the $\pi^{\pm}$ and the π^0. It is possible to obtain the right sign of $\Delta\mu$ only if the interaction which binds the states is produced by isoscalar pseudoscalar or isoscalar vector mesons, or with a mixture of isovector pseudoscalar plus isoscalar vector mesons. A cut off of the order of the mass of the π meson is used in the electromagnetic interaction to obtain the experimental value of $\Delta\mu$. (auth)

Weak

21967 COO-264-539) APPLICATION OF A VECTOR MESON DOMINANCE MODEL TO 2π AND 3π DECAYS OF K AND η MESONS. Haciniiyan, Avadis Simon (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies. Chicago Univ., Ill. Dept. of Physics). Mar. 1970. Contract AT(11-1)-264. 36p. (EFI-70-12). Dep. CFSTI.

P-wave contributions to $K \to 3\pi$ and $\eta \to 3\pi$ decays are systematically studied by means of a vector meson dominance model. Dalitz plot fits using functional dependences of matrix elements from the above model, and p-wave decay rate estimates using a generalized spurion concept yield reasonably consistent results for the p-wave contribution to these decays. (auth)

21968 (NYO-2262-TA-216) S-MATRIX ANALYSIS OF K_{l3} FORM FACTORS: ZERO OF THE $K\pi$ AMPLITUDE AND THE PARAMETER ξ. Kang, Kyungsik (Brown Univ., R. I. Dept. of Physics). [1969]. 10p. Dep. CFSTI.

An S-matrix calculation of the K_{l3} form factors is presented which gives the parameter $\xi \simeq -1$ in excellent agreement with the recent experiments. Existence of a zero in the $K\pi$ amplitude near the K_{l3} physical region and below the $K\pi$ threshold plays an important role. Implications of the amplitude zero to the off-mass-shell extrapolation of the form factors are briefly discussed. (auth)

21969 GENERATION AND INTERACTIONS OF HIGH-ENERGY MUONS. Kristiansen, G. B. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1482-94(Sep 1969). (In Russian).

Experimental data obtained on ionization burst spectra contradicted the theoretical burst spectra calculated by the ordinary assumptions on muon generation in π- and K decays. The experimental and theoretical spectra could be coordinated by assuming an existence of certain new processes of direct muon production in the studied event. Certain indications were found for the increased cross section for muon–nuclear interactions at 3×10^{11} to 3×10^{12} eV energies. (tr-auth)

21970 PARITY EFFECTS IN RADIATIVE Ω^- DECAYS. Raszillier, I. (Inst. of Physics, Bucharest); Burlacu, L. Z. Phys.; 233: 471-6(1970).

It is shown that, for values of the Ω^- magnetic moment near that predicted by SU(6), parity effects in radiative Ω^--decays are expected to be small and, contrary to the situation in hyperon decays, more pronounced in decays with heavy charged particles. They depend, however, sensitively on the moment of Ω^- and are insensitive to the hyperon moments. This is due to the dominance of a "contact" term which has to be introduced in the amplitude in order to ensure gauge invariance. (auth)

Strong (General)

21971 EQUATION OF STATE IN HYDRODYNAMIC THEORY OF MULTIPLE PARTICLE GENERATION. Sisakyan, I. N. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1576-80(Sep 1969). (In Russian).

Thermodynamic potential of a meson-nucleon plasma was calculated in a weak binding approximation. It was found that at temperatures T, lower than the nucleon mass m($\hbar = c = 1$) the disintegration is carried out according to $g(m/T)^{3/2} e^{-m/2T}$. It is shown that the equation of state used in a hydrodynamic theory of multiple particle generation varied in the dispersion process of the system. At temperatures larger than the mass of the heaviest particle in the plasma $c^2 = 1/3$ (c is the sound velocity) the c^2 diminished during dispersion process cooling of the system. (tr-auth)

21972 PROBLEMS IN THE THEORY OF STRONG INTERACTIONS. Feinberg, E. L.; Chernavskii, D. S. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1461-8(Sep 1969). (In Russian).

A brief review is given on the theory of multiple generation (the theory of peripheral interactions and statistical theory) at high energies. Various problems and concepts of the theory such as the amplitude concept and time inversibility are discussed. (tr-auth)

21973 RESONANCE SPECTROSCOPY. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel. Argonne National Lab., Ill.). pp 386-407 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

The theoretical interpretations of resonance spectroscopy are reviewed. Those aspects of the current theoretical approach that have been influenced by the concept of duality and by the continued experimental absence of resonances having exotic quantum numbers are emphasized. (41 references) (L.B.S.)

21974 STRONG INTERACTION DYNAMICS. Blankenbecler, R. (Stanford Univ., Calif.). pp 411-19 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

Two topics of current interest are discussed: the Veneziano representation and the relativistic eikonal formulas. Their successes, failures, and possibilities for strong interaction dynamics are described. (L.B.S.)

Strong (Baryon No. = 0)

21975 (COO-1051-38) ZERO-MASS STATES IN NON-FREDHOLM BETHE-SALPETER $q\bar{q}$ MODELS. Connell, John (Michigan State Univ., East Lansing). [28 Feb 1970]. 32p. Dep. CFSTI.

We consider a $q\bar{q}$ interaction given by a (non-Fredholm) Bethe-Salpeter equation whose kernel is a sum of S, V, T, A and P single boson exchange. With the heavy-quark model of mesons in mind, we determine when massless bound states of given tensor character (S,V,T,A or P) will occur, and what exchanged-particle coupling constants will produce them. The technique used is gradually to increase the magnitude of the coupling constants from zero, and determine when the lowest bound state mass descends to zero. This point is detected by the development of a singularity in the previously regular $s = 0$ scattering amplitude. The singular, non-Fredholm property of the Bethe-Salpeter equation allows considerable simplifications which make the calculation possible. (auth)

21976 (ITF-70-5) ANALYTICAL PROPERTIES OF THE EXACTLY SOLUBLE NONRELATIVISTIC TWO CHANNEL SCATTERING PROBLEM. Kharakhan, M. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 23p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The exactly soluble nonrelativistic example is investigated for the problem of the two-channel scattering of the two neutral spin-

less bosons. The explicit form for the S-matrix is derived in the form of the quotient of the matrixes of the Jost type. A previous suggestion is checked about the identities: $S_{12} = S_{21} = 0$, $S_{22} = 1$ in the region between the thresholds. It is demonstrated that these can be violated. The connection is observed between the identities and the T-invariance condition. The peculiar features of the scattering and reaction cross section are investigated for the case of the presence of the pole on the nonphysical sheet of the upper threshold in the region between the thresholds. (auth)

21977 CURRENT-ALGEBRA SELF-CONSISTENCY CONDITIONS FOR VECTOR AND AXIAL-VECTOR MESONS. Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 24: 691-4(23 Mar 1970).

Self-consistency conditions, derived for the vector and axial-vector mesons on the basis of current algebra and the soft-pion technique, imply that, if the A_1 is an axial-vector meson, its width due to the $\pi\rho$ decay should be much wider than the present world average. The broad enhancement $K_A(1200-1350)$, if it includes an axial-vector meson, should consist of a broad resonance that decays into $\pi K^*(890)$. Also, the decay $A_1 \rightarrow \pi + \sigma$, where σ is an isoscalar S-wave $\pi\pi$ resonance, should be small compared with its $\pi\rho$ decay, even if the σ appears at 700 MeV. (auth)

21978 MESONS. Derrick, M. (Argonne National Lab., Ill.). pp 291-385 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

A review is given of the experimental data on meson resonances in the mass region from threshold to 1500 MeV. In addition, the present state of knowledge of the meson formation experiments from about 2 to 3 GeV using $\bar{p}$ beams is briefly covered. The nonrelativistic quark model is used to provide a framework for the low-mass region. (112 references) (L.B.S.)

21979 THE rho^0 MESON WIDTH AND THE VECTOR MESON DOMINANT MODEL. Bramon, A. (Instituto de Fisica Teorica, Barcelona). Fizika (Zagreb); 2: 37-9(1 Jan 1970).

The width of the ρ meson is found from the evaluation of the coupling constant, which in turn follows from the branching ratio for ω decay. The coupling constant is found to be 2.5 ± 0.3, and the resulting ρ width for $\rho \rightarrow \pi^+ + \pi^-$ decay is 130 ± 14 MeV. The vector dominance model is used exclusively. (J.F.P.)

21980 BOUNDARY CURVES OF THE DOUBLE SPECTRAL FUNCTIONS IN THE MANDELSTAM REPRESENTATION. Rasche, G. (Univ., Zurich); Woolcock, W. S. Helv. Phys. Acta; 43: 179-202(Apr 1970).

The boundary curves of the double spectral functions in the Mandelstam representation for the invariant amplitudes of a two-particle → two-particle collision process are evaluated for a number of hadronic processes. Use is made only of elastic unitarity and of "extended" unitarity and a general formula is given which applies to any case where an anomalous threshold is absent. It is shown that subtractions in the Mandelstam representation do not alter the boundary curves. (auth)

Strong (Baryon No. = 1)

21981 MANY-PARTICLE PROCESSES AT ACCELERATING ENERGIES. Chizhevskii, O. (Inst. for Nuclear Research, Krakow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1532-43(Sep 1969). (In Russian).

Data obtained on multiparticle interactions were compared with various models (fireball models, multiperipheral Regge model and Satz quark model). The importance of diffraction processes in the multiple reactions is discussed. (tr-auth)

21982 POSSIBILITY OF EVALUATING PRIMARY PROTON ENERGIES. Dedenko, L. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1583-4(Sep 1969). (In Russian).

Calculations of electron distributions and analysis of published data indicate that the ratio of the upper extreme magnitude N_{max} of the number of electron distribution to the energy of primary protons E_0 is equal to $N_{max}/E_0 \approx$ (1 to 0.8) GeV^{-1} and does not, practically, depend on the magnitude of E_0, the height of the level of observations in the lower hemisphere, and the model of elementary particle interactions. The relation was used for evaluating the energy of initial protons generating showers with an assigned number of muons or with an assigned Cherenkov spark at the level of observation. Correlations with experimental data showed that the model used in the calculation is in agreement with the data obtained. (tr-auth)

21983 $\pi\pi$ SYSTEMS IN THE DECAY OF THE LOW-MASS K$\pi\pi$ ENHANCEMENT. Bowler, M. G. (Oxford Univ.). Phys. Lett.; 31B: 318-20(2 Mar 1970).

It is shown that the results of a comparison of the low-mass K$\pi\pi$ system in the two states $K^+\pi^-\pi^+$ and $K^0\pi^0\pi^+$ necessitate a substantial amount of an $I = 0$ $\pi\pi$ system in addition to the established $K^*(890)$ and ρ decay modes. (auth)

21984 POSSIBILITY AND LIMIT OF THE POMERANCHUK VIOLATING AMPLITUDE IN PION NUCLEON SCATTERING. Lam, W. S.; Truong, T. N. (Ecole Polytechnique, Paris). Phys. Lett.; 31B: 307-9(2 Mar 1970).

Some remarks on the Pomeranchuk theorem are made and experimental consequences of the possible violation are discussed. Depending on the form assumed for the violating amplitude, subjected to experimental verifications, in one case a limit of 1% while the other of 0.05% are obtained for the ratio of the imaginary part of the Pomeranchuk violating amplitude to the conserving one. (auth)

21985 BROKEN EXCHANGE DEGENERACIES AND SECONDARY TRAJECTORIES IN CHARGE AND HYPERCHARGE REACTIONS. Auvil, P. R.; Halzen, F.; Michael, C.; Weyers, J. (CERN, Geneva). Phys. Lett.; 31B: 303-6(2 Mar 1970).

A simple model is developed for the difference of K and $\bar{K}$ nucleon charge exchange cross-sections. In addition to a breaking of exchange degeneracy, the model requires secondary trajectories which are identified with the scalar meson trajectories. Hypercharge exchange reactions are also discussed. (auth)

21986 REGGE-POLE DESCRIPTION OF K^+p BACKWARD SCATTERING. Gizbert-Studnicki, P.; Golemo, A. (Jagellonian Univ., Krakow). Acta Phys. Pol.; A37: 143-50(Jan 1970).

Regge fits to the K^+p backward differential cross section with the exchange of $\Lambda_\alpha(1115, \frac{1}{2}^+)$ and $\Lambda_\gamma(1520, \frac{3}{2}^-)$ trajectories are presented. Assumptions of complete and partial $\Lambda_\alpha - \Lambda_\gamma$ exchange degeneracy are tested. The results are compared with FESR predictions. (auth)

21987 S = 0 BARYON RESONANCES. Plano, Richard J. (Rutgers-The State Univ., New Brunswick, N. J.). pp 185-237 of Proceedings of Boulder Conference on High Energy Physics. Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

The experimental status of the nucleon resonances is reviewed with a concentration on developments since the reviews of Donnachie and Rushbrooke at the Vienna conference of 1968. Comments are made on the technique of phase shift analysis-on how resonance parameters can be extracted from Argand diagrams and the possibility of assigning realistic errors to these derived parameters. New data are presented on $\pi N \rightarrow \pi N$, $\pi N \rightarrow N\pi\pi$, production of N*(1470), and the d*(2200). (64 references) (L.B.S.)

21988 SUMMARY ON S = -2 BARYON STATES. Chang, C. Y. (Univ. of Maryland, College Park). pp 238-46 of Proceedings of Boulder Conference on High Energy Physics. Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

The masses, widths, decay modes and the present status of the Ξ states are summarized. The experiments that have contributed substantially to the knowledge of the Ξ states are listed. The essential features of the data of the Brandeis-Maryland-Syracuse-Tufts Collaboration are summarized. The BMST data demonstrated the existence of $\Xi(1630)$, which decays into $\Xi^-\pi^+$, and evidence that both $\Xi(1815)$ and $\Xi(1940)$ decay into $(\Xi\pi)^0$ and $(\Xi(1530)\pi)^0$ simultaneously. (L.B.S.)

21989 A POSSIBLE NON-REGGE BEHAVIOR OF THE πN AMPLITUDE AT HIGH ENERGIES. Hoehler, G.; Steiner, F.; Strauss, R. (Univ., Karlsruhe, Ger.). Z. Phys.; 233: 430-44(1970)

The total cross sections up to 65 GeV/c and the experimental real parts of the isospin even πN forward amplitude are compatible with the dispersion relation. However the arguments which led to the introduction of the P′ Regge pole ($\alpha_{P'} \approx 0.5$) are not valid. The data are compatible with the existence of the integral in Lehmann's sum rule, which implies a finite real part $D^+(\infty)$ at infinity. The isospin odd combination σ^- is still consistent with the reggeized p-exchange model and with Pomeranchuk's theorem. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 21981 and 22201.

21990 (BNL-50210) THE SMALL DISTANCE FRONTIER. Brookhaven Lecture Series Number 77. Collins, George B. (Brookhaven National Lab., Upton, N. Y.). 23 Oct 1968. 6p. Dep. CFSTI.

Proton scattering by protons is described using various models. Center-of-mass scattering is described using the analogy of billiard balls. Then each proton is likened to a sphere with its substance distributed over its volume in a cloudlike effect. Collisions are likened to two swarms of bees colliding. Finally the quark model is used to describe these proton–proton interactions. (J.F.P.)

21991 DISTRIBUTIONS IN TRANSVERSE MOMENTUM FOR DEEPLY INELASTIC HADRON COLLISIONS. Yen, Edward; Berger, Edmond L. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 24: 695-8(23 Mar 1970).

Explanation is given for observed sharp forward peaks in distributions of transverse momentum for hadrons produced in deeply inelastic hadron collisions. Small Q-value decay of peripherally produced nucleon resonances is the basic mechanism responsible for peaks in both π and proton spectra. Implications of this result are discussed. (auth)

21992 POLARIZATION IN ELASTIC NUCLEON–DEUTERON SCATTERING. Krauss, J.; Kowalski, K. L. (Case Western Reserve Univ., Cleveland). Phys. Lett.; 31B: 263-5(2 Mar 1970).

Two-nucleon tensor forces were included in an approximate calculation of elastic nucleon-deuteron scattering at 14.4 and 22.7 MeV. Polarizations in reasonable agreement with experiment are obtained. (auth)

21993 MESON EXCHANGE CORRECTION TO THE $p + p \rightarrow d + e^+ + \nu^*$ REACTION AND TO THE β DECAY OF SOME MIRROR NUCLEI. Rozenblit, M. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Lett.; 31B: 266-8(2 Mar 1970).

Previous calculations of the meson exchange correction to the p + p reactions, and meson exchange effects for some mirror nuclei are discussed. It is found that the exchange corrections are important and in particular the contribution of the Yukawa potential cannot be neglected with respect to the Yukawa π potential. The Yukawa ρ potential becomes relatively smaller than the Yukawa π potential only when applied to wave functions with hard core or which are strongly depressed near the origin. (J.F.P.)

21994 BEHAVIOR OF NUCLEON–NUCLEUS INTERACTION CROSS SECTION IN THE HIGH ENERGY REGION. Balashov, V. V.; Korenman, G. Ya. (Moscow State Univ.). Phys. Lett.; 31B: 310-12(2 Mar 1970).

The data on the proton-nucleus interaction in the 20-600 GeV range obtained in experiments on the "proton" satellites were analyzed in terms of Glauber's model. Estimates of possible increase of the nucleon-nucleon cross section with energy are given. (auth)

21995 REGGE CUT AS OPTICAL POTENTIAL IN HIGH-ENERGY LARGE-ANGLE pp SCATTERING. Islam, M. M. (Univ. of Connecticut, Storrs). Phys. Lett.; 31B: 313-17(2 Mar 1970).

It is shown that the fixed Regge-cut amplitude coming from a Mandelstam diagram with one Regge pole and one elementary particle exchange can be identified with the optical potential in high-energy large-angle pp scattering. The argument is based on Rothe's quantitative estimate of the Regge-cut amplitude. (auth)

21996 ANALYSIS OF pp SCATTERING AT 640 MeV BY TAKING INTO ACCOUNT THE TOTAL CROSS SECTIONS AND π MESON ANGULAR DISTRIBUTIONS. Vovchenko, V. G.; Zul'karneev, R. Ya.; Kiselev, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 58: 825-30(Mar 1970). (In Russian).

A phase shift analysis of 640 MeV pp collisions is performed. In distinction to previous work the present analysis is carried out by taking into account the $\pi^{+,0}$ meson angular distributions. Four approximately equally probable solutions are obtained. More precise experimental data on elastic pp scattering are necessary in order to make the analysis less ambiguous. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 21908 and 22004.

21997 SPONTANEOUS BREAKDOWN OF CONFORMAL SYMMETRY. Isham, C. J.; Salam, A.; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 31B: 300-2(2 Mar 1970).

Any Lorentz-invariant Lagrangian can be made conformally invariant provided a gauge field ϕ_μ is introduced as part of a covariant derivative. The field ϕ_μ, whose transformations are thus symptomatic of spontaneous symmetry breakdown, is decomposed into transverse and longitudinal pieces whose properties and possible manifestations are discussed. Among them is a natural place for C-violation. (auth)

21998 INVARIANT QUANTITIES IN A SIMPLE GROUP G_2. Scheibling, F. (Centre National de Recherches Nucleaires, Strasbourg); Umezawa, M. Kon. Ned. Akad. Wetensch., Proc., Ser. B, 73: 22-32(1970).

The invariant operators of one of the exceptional Lie groups namely, G_2, are considered. First Weyl's S-group of the group G_2 is investigated. Then the invariant operators are determined by using the fact that they are also invariant for the reflections of the root diagram. (auth)

Applications (Electromagnetic and Weak)

21999 DECAYS OF BARYONS IN THE U(6) x U(6) x U(3) SYMMETRY SCHEME. Sultoon, J. (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A; 315: 249-58(24 Feb 1970).

Assuming that the baryon states are represented by supermultiplets of the oscillator excitation group $U(6) \times U(6) \times U(3)$, the two-body decay widths of the lowest submultiplets, where the couplings are invariant under the collinear group $U(6) \times U(2)$, are calculated. A simplified model of octet–octet mixing is considered, which generally demonstrates the importance of mixing in controlling decay widths. Mass splitting is accounted for by using average SU(6) masses (for a given orbital excitation) in the couplings and physical masses to calculate the phase space factors of the decays. (auth)

22000 STATUS OF CP VIOLATION. Wojcicki, Stanley G. (Stanford Univ., Calif.). pp 137-63 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

A brief review is given of the historical background of the CP problem. The experimental situation is then reviewed with emphasis on those experiments where a two or three standard deviation can be found in a given process, and experiments dealing directly with the $K^0-\bar{K}^0$ system. Results of measurements of the parameters η_+, η_{00}, arg ϵ, and arg ϵ' are summarized. It is concluded that the $K^0-\bar{K}^0$ system has so far provided the only source of definite evidence on CP violation. (L.B.S.)

Applications (Strong)

22001 DESCRIPTION OF UNSTABLE PARTICLES BY NON-UNITARY IRREDUCIBLE REPRESENTATIONS OF THE POINCARE GROUP. Simonius, Markus (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 43: 223-34(Apr 1970).

A formalism is presented which allows a simultaneous treatment of independent unstable particles (in a beam) and unstable intermediate states in a scattering process. The unstable particles are described by nonunitary representations of the Poincaré group. The quantum mechanical formalism appropriate to cope with nonunitary group representations is presented. It is found that the spin of an unstable particle is not necessarily a well-defined quantity. For an intermediate state formed by a particle which does have a well defined spin the usual resonance formula is recovered. (auth)

Field Theories

Refer also to abstract 21944.

Quantum Field Theory

22002 DOES RENORMALIZED PERTURBATION THEORY DIVERGE. Bender, Carl M. (Inst. for Advanced Study, Princeton, N. J.); Mandula, Jeffrey E.; McCoy, Barry M. Phys. Rev. Lett.; 24: 681-3(23 Mar 1970).

Renormalized perturbation theory in the anharmonic oscillator diverges. (auth)

22003 DOES A ROD, PUSHED BY A FORCE, ACCELERATE LESS THAN THE SAME ROD PULLED BY THE SAME FORCE? Cavalleri, G. (Politecnico, Milan. CISE, Milan); Spinelli, G. Nuovo Cim.; 66B: 11-20(11 Mar 1970).

The answer is yes, if we consider the mean accelerations of the rod's points. Namely, the acceleration of the application point of the external force only depends on the rod's mass and the force's magnitude. Consequently the other points of the rod accelerate differently according to their positions in order to set up Lorentz contraction. The problem is solved kinematically, considering that the rod's motion is rigid if the external force is constant and assuming that the motion of the application point of the external force is hyperbolic. The above assumption then proves to be in agreement with the relativistic equations of motion for elastic continua. Moreover, by these equations, the acceleration of the application of the external force turns out to be given, in any instantaneous rest system of inertia, by F/m_0, where F is the force's magnitude and m_0 the rod's proper mass. The problem is studied also by the equations recently proposed by Cavalleri and Salgarelli in the context of a new formulation called "asynchronous," to distinguish it from the usual "synchronous" formulation of the relativistic dynamics for extended bodies. By the asynchronous equations, the hyperbolic motion for the rod can be immediately deduced. The problem studied can interest models of extended particles, "pushed or pulled" by exchanges of real and virtual photons, mesons, gravitons. (auth)

22004 INVARIANCE AND CONSERVATION LAWS FOR A CLASSICAL RELATIVISTIC PARTICLE. Denman, Harry H.; Kiefer, Harold M. (Wayne State Univ., Detroit). Amer. J. Phys.; 38: 300-4(Mar 1970).

The general equation of motion of a classical relativistic particle, moving in one dimension, is examined to determine what results are implied by the invariance of this equation to a number of well-known space-time transformations, i.e., the space and time translations, scale changes and inversions, and the Lorentz transformations. While the invariance of the equation to a translation alone generates a conservation law, invariance to the others does not. Conditions on the Lagrangian describing the system for invariance to these transformations are also given. While invariant Lagrangians yield equations of motion with the same invariance, Lagrangians exist that are not invariant to certain transformations but that produce invariant equations of motion. For the Lorentz transformations, the invariance of $\int L dt$ is also examined. Further, it is shown that invariance of the equation of motion to Lorentz transformations provides a definition of the relativistic linear momentum that is independent of the Lagrangian or any assumed conservation law. (auth)

22005 DIAGONALIZATION AND RENORMALIZATION OF THE ONE-BOSON LEE MODEL. Trubatch, S. L. (California State Coll., Long Beach). Amer. J. Phys.; 38: 331-4(Mar 1970).

Renormalization in simple quantum mechanical systems is illustrated by diagonalizing the Hamiltonians for the displaced harmonic oscillator and the one-boson Lee model. The diagonalizing transformation for the one-boson Lee model is found by generalizing its dressing transformation. The renormalized fermion masses in the diagonalized Hamiltonian are found to be q numbers. (auth)

22006 ANALOGY BETWEEN MAXWELL ELECTROMAGNETIC THEORY IN SPECIAL RELATIVITY THEORY AND EINSTEIN GRAVITATION THEORY. Bredimas, Antoine (Univ., Paris). Compt. Rend., Ser. A; 270: 493-6(16 Feb 1970). (In French).

The correspondence between Maxwell electromagnetic theory and Einstein gravitation theory, and more particularly between gauge conditions and transformations and co-ordinate conditions and transformations, is studied. An analogy between these two theories is deduced from the asymptotic study of electromagnetic and gravitational radiations. (auth)

22007 PARTICLES THAT TRAVEL FASTER THAN LIGHT. Newton, Roger G. (Indiana Univ., Bloomington). Science; 167: 1569-74(20 Mar 1970).

Particles traveling faster than light are discussed covering the speed of light, the speed limit on signals, causality, and quantum mechanics. It is concluded that it is not impossible for superluminal particles to exist, but that if they were found and identified the consequences for physics would be far-reaching. (J.F.P.)

Gravitation and General Relativity

Refer also to abstracts 21449 and 21513.

22008 GRAVITATIONAL LIGHT–LIGHT AND LIGHT-PARTICLE SCATTERING: COMPARISON BETWEEN THE CLASSICAL (GENERAL-RELATIVISTIC) AND QUANTUM FIELD-THEORETIC RESULTS. Westervelt, P. J.; Karr, L. F. (Brown Univ., Providence). Nuovo Cim.; 66B: 129-36(11 Mar 1970). (NYO-2262TA-209).

The classical general-relativistic cross sections for the scattering of either a photon or a particle by a single photon of negligible spatial extent are calculated and found to agree, for small angles, with the results of the quantized linearized field theory. The differences between the scattering by a single photon and the scattering by a steady pencil of light are resolved. (auth)

22009 REMARK ON THE HARMONIC RADIUS VECTOR. Buchdahl, H. A. (Australian National Univ., Canberra). Amer. J. Phys.; 38: 291-4(Mar 1970).

Certain questions relating to the definition of, and the uniqueness of, the "harmonic radius vector" as introduced by Fock within the general theory of relativity are considered.

22010 THE MERRY-GO-ROUND AND SCHWARZSCHILD COORDINATES: A COMPARISON. Laurent, B. E. (Univ. of Stockholm. Brandeis Univ., Waltham, Mass.). Amer. J. Phys.; 38: 492-4(Apr 1970).

The behavior of the Schwarzschild metric inside the gravitational radius is compared to the behavior of the flat-space metric in rotating coordinates when $r\omega > 1$. In both cases the time is imaginary and the spatial line element indefinite with regard to sign. In both cases the physical interpretation is the same: Observers at rest (in the coordinate system) do not exist. (auth)

Scattering Theory

Refer also to abstract 21908.

22011 (CNRS-CPT-69-P-315) ALGEBRAIC APPROACH TO QUANTUM SCATTERING THEORY. Combes, J. M. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). 1969. 37p. Dep. CFSTI (U. S. Sales Only).

In the theory of scattering by long range potentials, the asymptotic behavior of operators was investigated. A weak asymptotic condition was introduced, and the mathematical consequences of that condition were discussed. Then the existence of asymptotic algebras in potential scattering by a control field or a two particle interaction was studied. (auth)

22012 (COO-264-537) THE N-PARTICLE DUAL AMPLITUDE WITH SATELLITES: WARD-LIKE IDENTITIES. Rivers, R. J. (Chicago Univ., Ill. Enrico Fermi Inst.). Feb 1970. Contract AT(11-1)-264. 23p. (EFI-70-10). Dep. CFSTI.

A large class of N-pt. functions with satellites factorized in a multiperipheral configuration is examined. It is shown that the Ward-like identities due to reflection invariance do not lead to a reduction in degeneracy due to a partial ghost-killing but merely lead to the introduction of new states. This is considered to be a more serious disadvantage to the model than the large mass degeneracy that satellites imply. (auth)

22013 (COO-264-541) FACTORISATION OF SATELLITE TERMS IN THE N PARTICLE DUAL AMPLITUDE. II. THE SINGLE PLANAR DUAL LOOP. Frampton, P. H.; Rivers, R. J. (Chicago Univ., Ill. Enrico Fermi Inst). Mar 1970. Contract AT(11-1)-264. 23p. (EFI-70-15). Dep. CFSTI.

The amplitude for a single planar dual loop is written for a loop constructed from a factorized N particle dual amplitude with satellite terms included. The end-point essential singularity, already present in the non-satellite case, is strengthened due to the increased degeneracy of the states, and there is no possibility of cancelling the singularity by manipulating the satellite coefficients. Unequal intercepts are introduced with satellite terms present. The operational coherent state formalism is used throughout to facilitate the calculation. Some remarks are made concerning the incompleteness of the analogy between the dual diagrams and the Feynman diagrams of quantum electrodynamics. (auth)

22014 (COO-264-542) COMPLEX POMERANCHUK TRAJECTORIES. Oehme, Reinhard (Chicago Univ., Ill. Enrico Fermi Inst, Chicago Univ., Ill. Dept. of Physics). Mar 1970. Contract AT(11-1)-264. 12p. (EFI-70-16). Dep. CFSTI.

Models for diffraction scattering are presented which contain complex Pomeranchuk trajectories and moving branch points of the type generated by these trajectories. Poles and cuts are correlated so as to remove unwanted branches of the pole surfaces from the physical sheet. (auth)

22015 (JINR-P5-4928) ON EQUIVALENT REGULARIZATIONS OF THE SCATTERING PROBLEM ON STRONGLY SINGULAR POTENTIALS. Arsen'ev, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1970. 13p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A new method is suggested for reducing the problem of scatter-

ing on the singular potential to the Fredholm equation with a nonsingular kernel. It is proved that the Laplace transformations of any function $\mu(\beta)$ from a rather wide group can be used as a regularizing function and the solution of the problem is a smooth function beyond the singular potential points. (auth)

22016 DETERMINATION OF THE POLES FOR S MATRIX IN THE PLANE OF COMPLEX ORBITAL MOMENT. Yanavichyus, A. (State Pedagogical Inst., Siauliai, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet TSR Aukst. Mokyklos; 9: 299-302 (1969). (In Russian).

It is shown that the pole of the scattering matrix $S(\lambda,k)$ for λ_0^I, k_0^I corresponds to the pole $-\lambda_0, -k_0$. This fact shows that, when one searches poles $a(k^2)$ in the λ-plane as the function of k^2 or the energy, one can find its real part with any sign. This result allows calculation of the interaction potentials of α particles. The obtained interaction potentials for the energies: 3.48, 7.6, 10.2 MeV are illustrated. (auth)

22017 SOME ANALYTIC PROPERTIES OF A SCALAR BETHE-SALPETER EQUATION. Tang, I-ming. Cincinnati; Univ. of Cincinnati (1969). 61p.

Thesis.

The Bethe Salpeter equation for scalar particles is written down emphasizing the role played by the scattering angle when continued into the unphysical region. It is found that two very similar equations, often referred to as the "inner" and "outer" equations, allowing for different partial wave analyses result if certain inequalities concerning Lehmann ellipses are met. The partial wave analysis of the "inner" (true) BS equation is pursued for the special case of a massless exchange particle. Interest in this particular case lies in the fact that the equation has a separable differential form in this instance. Use is made of the addition theorem for Legendre functions of the second kind to obtain closed form partial wave amplitudes. The partial wave summation is actually performed to obtain the full scattering amplitude. A connection between the solutions of the "inner" and "outer" equations on the second Riemann sheet where the "outer" equation has an exact and nontrivial solution even for the general mass case is accomplished by replacing the Δ_t exchange particle propagator by either a Δ_1 or Δ_{ret} function. The $l = 0$ and $l = 1$ solutions of the "outer" equation is then presented. (Diss. Abstr.)

22018 QUASICLASSICAL APPROXIMATION FOR MULTICHANNEL SCATTERING. Dubrovskii, G. V. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 58: 1075-85(Mar 1970). (In Russian).

A quasiclassical method is proposed for determining the multichannel S-matrix for an arbitrary number of channels under consideration. The role of turning points in multichannel scattering and methods for taking them into account in setting up the S-matrix are discussed. An analytic expression for the S-matrix is found by the phase integral technique for the case of binary electron level "pseudo-intersection." The expression can be employed for numerical calculations. (auth)

22019 RELATIVISTIC EIKONAL APPROXIMATION. Andreev, I. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 58: 253-6(Jan 1970). (In Russian).

An approximation resembling the eikonal method in potential theory is presented for the scattering amplitude of two relativistic particles. Applications of the approximation to scattering of high energy particles are discussed. (auth)

22020 REVIEW OF REGGEISM. Durand III, Loyal (Univ. of Wisconsin, Madison). pp 421-53 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

A broad summary is given of the present status of Regge-type models for scattering amplitudes, with special emphasis on recent developments in the theoretical background and phenomenological application of these models. (L.B.S.)

Particle Accelerators

Refer also to abstracts 20793, 21024, 21906, 21955, and 22075.

22021 (AERE-R-6254) A VARIABLE GEOMETRY SEPARATOR AND LOW ENERGY HEAVY ION ACCELERATOR. PART I. GENERAL PRINCIPLES. Freeman, J. H. (Atomic Energy Research Establishment, Harwell (England)). Jan 1970. 21p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

The new Harwell isotope separator and heavy ion accelerator was designed as a compact laboratory facility for the separation of high purity isotopes as well as for a wide range of ion interaction studies. The novel focusing arrangements permit considerable experimental flexibility, with a resolution and dispersion comparable with much larger conventional separators. The high beam intensity of the machine is adequate for production-scale semiconductor doping. (auth) (UK)

22022 (AERE-R-6300) A 3-MeV PROTON BEAM OF LESS THAN FOUR MICRONS DIAMETER. Cookson, J. A.; Pilling, F. D. (Atomic Energy Research Establishment, Harwell (England)). Jan 1970. 10p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

A focusing system using high precision magnetic quadrupoles was designed and built for use with the IBIS Van de Graaff generator. Measurements of the first order focusing and the aberrations agreed satisfactorily with theoretical predictions. The focused beam of 3 MeV protons was measured to have a diameter of less than 4 μm. (auth) (UK)

22023 (CERN-70-3) THE ISOLDE ISOTOPE SEPARATOR ON-LINE FACILITY AT CERN. Kjelberg, A.; Rudstam, G. (eds.) (European Organization for Nuclear Research, Geneva (Switzerland)). 19 Jan 1970. 140p. Dep. CFSTI (U. S. Sales Only).

An experimental arrangement intended for the study of short-lived nuclides is described. An electromagnetic isotope separator is connected to a target irradiated by 600 MeV protons from the CERN Synchrocyclotron, and isotopically pure nuclear reaction products are obtained at the measuring position of spectroscopic instrumentation. The facility allows simultaneous study of several masses. Since the start of operation in October 1967, eight different target systems have been used, and nuclides of half-life down to one second have been studied. (auth)

22024 (CERN-70-7) HAMILTONIAN MECHANICS WITH A SPACE COORDINATE AS INDEPENDENT VARIABLE. CANONICAL THIN LENS APPROXIMATION FOR AN ACCELERATING GAP. Schnizer, B. (European Organization for Nuclear Research, Geneva (Switzerland)). 13 Mar 1970. 49p. Dep. CFSTI (U. S. Sales Only).

For application in linear accelerators a kind of Hamiltonian mechanics is developed where the longitudinal space coordinate, z, is the independent variable in place of time, t. This is done by changing in Hamilton's principle the variable of integration from t to z and by employing afterwards the usual Legendre transformation. The corresponding Lagrangian, Hamiltonian, canonically conjugate variable, and canonical transformations are discussed. Poisson and Lagrange brackets and the Poincaré invariants are listed. In general symmetry inherent to Hamiltonian mechanics is demonstrated in an eight-dimensional version, treating on an equal footing the four canonically conjugate pairs x, p_x; y, p_y; z, p_z; t, p_t; t, $p_t = -E$ (E = total energy). Any among these variables may be chosen as the independent one; in certain (but not all) cases its canonically conjugate partner is the Hamiltonian and the three remaining pairs give the set of dependent variables. Also, in the so-called thin lens approximation the real trajectory of a single proton crossing a gap of a linac Alvarez structure is replaced by a fictitious one consisting of step functions as if the gap were reduced to its median plane. A thin lens Hamiltonian is derived from which these increments can be derived by partial derivations. By canonical transformations a complete set of reduced variables is introduced. Reduced variables are constant in the absence of fields acting on the particle. The transformed Hamiltonian is solved by iterations starting from free particle motion. To first order it depends only on the constant mid-gap values of the reduced variables and on the independent variable, the longitudinal space coordinate. Integrating across the gap gives the thin lens Hamiltonian. By this method are derived the modified Panofsky equations for the change of kinetic energy and phase across a linac gap in the one-dimensional problem. If transversal motion is also taken into account it turns out that the radial reduced variables differ from those used in the usual linac beam dynamics difference equations. From this and from the coupling between longitudinal and radial motion it follows that radial phase space area is not observed. (auth)

22025 (CERN-Trans-69-32) SOME PROBLEMS OF THE AUTOMATIC CORRECTION OF BETATRON OSCILLATIONS IN CYCLIC ACCELERATORS. Burshtein, E. L.; Roginskii, L. A. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by B. C. Hodge and revised by N. Mouravieff (CERN, Geneva, Switzerland), from report NTD-6818. 5p. Dep. CFSTI (U. S. Sales Only).

The equations for the moments of the particles are derived, and the beam dimension correction equation is studied, using as an example the suppression of parametric resonance. (W.H.K.)

22026 (CERN-Trans-69-34) RADIAL AND PHASE BEAM POSITIONING DEVICE FOR 70-GeV SYNCHROTRON. Chirkov,

S. V. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by A. T. Sanders and revised by N. Mouravieff (CERN, Geneva, Switzerland), from report NTD-6824. 7p. Dep. CFSTI (U. S. Sales Only).

The operation of an automatic system for controlling the radial position of the center of gravity of the beam and the phase of the beam in a 70-GeV synchrotron is briefly described. (W.H.K.)

22027 (CERN-Trans-69-35) ELECTROSTATIC INJECTOR OF A SMALL-APERTURE ACCELERATOR. Vasil'ev, A. A.; Batskikh, G. I.; Klenov, G. I. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by A. T. Sanders and revised by N. Mouravieff (CERN, Geneva, Switzerland), from report NTD-6819. 10p. Dep. CFSTI (U. S. Sales Only).

The main parameters of the Van de Graaff beam injector for the prototype cybernetic accelerator are briefly discussed. The high-frequency ion source, focusing lenses, and stabilization system are described. (W.H.K.)

22028 (JINR-E9-4915) CALCULATION OF THE GEOMETRY OF MAGNETIC CHANNELS FOR SYNCHROCYCLOTRONS AND CYCLOTRONS. Carbonel, B.; Danilov, V. I.; Ianovich, M.; Polferov, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 69p. Dep. CFSTI (U. S. Sales Only).

A program written in FORTRAN-63 for the calculation of magnetic extracting or focusing channels for particle accelerators has been set up. The program calculates the geometrical parameters which are necessary to obtain the required field for an extracting channel, or the field and gradient for a focusing channel with a precision of 2% and 10%, respectively. The program is aimed at computing the number and parameters of correction shims which correct the perturbation field produced by the channel towards the machine center. (auth)

22029 (LA-4384) QUARTERLY STATUS REPORT ON THE MEDIUM-ENERGY PHYSICS PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1970. (Los Alamos Scientific Lab., N. Mex.). 25 Mar 1970. Contract W-7405-eng-36. 46p. Dep. CFSTI.

Topics include the safety program, construction of accelerator structures, rf power systems, accelerator control and instrumentation, accelerator physics, the experimental area, LAMPF users group, LAMPF scheduling and construction, and physics research. (W.H.K.)

22030 (LFEN-NI.-41-a) TRANSPORT OF A BEAM OF CHARGED PARTICLES USING ELECTROMAGNETIC QUADRUPOLES. [PART] I. Dias, M. G. Figueiredo (Junta de Energia Nucleare, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 41p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The theoretical principles of the use of electromagnetic quadrupoles in the focusing of charged particle beams are discussed. The association of two quadrupoles is studied and the method of alignment of their magnetic axes is presented. A concrete example is given. (tr-auth)

22031 (NAL-38) FIRST PRODUCTION BENDING MAGNET. Monthly Report of Activities. Cole, F. T. (National Accelerator Lab., Batavia, Ill.). 31 Jan 1970. 8p. Dep. CFSTI.

Construction progress on the main-ring enclosure, booster, cross gallery, industrial buildings, and master substation is very briefly described. Progress on the linac, main accelerator, rf system, and experimental facilities are outlined. (W.H.K.)

22032 (NAL-39) THE MAIN RING TAKES SHAPE. Monthly Report of Activities. Cole, F. T. (National Accelerator Lab., Batavia, Ill.). 28 Feb 1970. 13p. Dep. CFSTI.

Construction progress on the booster enclosure, cross gallery, central utility plant, main accelerator, and industrial buildings is summarized. Progress on the linac, booster, main accelerator, rf system, beam transfer system, and experimental facilities are outlined. (W.H.K.)

22033 (NBS-TN-515) USE OF AN ON-LINE COMPUTER IN NEUTRON TIME-OF-FLIGHT MEASUREMENTS. Heaton II, H. T. (National Bureau of Standards, Washington, D. C.). Jan 1970. 31p. GPO $0.35.

The SDS-920 computer on-line data handling system at the NBS electron linac is described as it is used for measuring neutron total cross sections by time-of-flight techniques. (W.H.K.)

22034 (RHEL/R-188) NIMROD OPERATION AND DEVELOPMENT. Quarterly Report April 1-June 30, 1969. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). Nov 1969. 23p. Dep. CFSTI (U. S. Sales Only). UK 4s.

Details are given of Nimrod operation during April 1 to June 30, 1969, and of the particle physics experimental program undertaken. (U.K.)

22035 (SLAC-116) TWO-MILE ACCELERATOR PROJECT, Quarterly Status Report, October 1 to December 31, 1969. (Stanford Linear Accelerator Center, Calif.). Mar 1970. Contracts AT(04-3)-400 and AT(04-3)-515. 65p. Dep. CFSTI.

A status report on the Stanford Linear Accelerator Project covering the period October 1, 1969 to December 31, 1969, is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. (auth)

22036 (UCRL-19368) CONCRETE ACTIVATION EXPERIMENT AT THE BEVATRON. Gilbert, W. S.; Goebel, K.; Patterson, H. W.; Smith, A. R. (California Univ., Berkeley. Lawrence Radiation Lab.). 18 Dec 1969. Contract W-7405-eng-48. 32p. Dep. CFSTI.

^{24}Na-activity produced in concrete aggregate and its major elemental constituents (Na, Mg, Al, Si, and Ca) was measured as a function of depth in ordinary and boron-loaded concrete at the Berkeley 6.2-GeV Bevatron. These measurements were made at two locations in the Bevatron main shielding wall adjacent to strong local radiation sources. At one site, additional exposures were made with a boric acid wall in front of the concrete shield wall, in order to study the influence of boron spatial distribution on thermal-neutron production of ^{24}Na from sodium. The influence of several ^{24}Na-producing reactions on the dose rate in the main vault was evaluated for the different experimental conditions. Suppression of thermal flux was assessed by introducing a neutron poison, either into the structural concrete of the shield or as a thin layer on the inner surface of the shield. Practical implications of these studies are discussed. (auth)

22037 (UCRL-19386) RADIATION STUDIES AT A MEDIUM ENERGY ACCELERATOR. Stephens, Lloyd D.; Miller, Alvin J. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1969. Contract W-7405-eng-48. 47p. (CONF-691101-16). Dep. CFSTI.

From 2nd International Conference on Accelerator Dosimetry and Experience, Stanford, Calif.

Effective attenuation lengths were measured through the shielding walls at several angles from the target at the Berkeley 88-inch cyclotron. Attenuation of neutrons was measured for walls composed entirely of concrete, as well as of concrete and iron, or of concrete, iron, and sand. Variations in shielding efficiency were determined. Neutron flux measurements have been made along an extended beam line in an effort to improve beam transport and reduce personnel irradiation. Also, extensive activation studies of many accelerator parts were made. These studies prove their worth in maintenance planning, for which it is desirable to minimize personnel exposures. A sampling of the measurements of the external radiation field produced by the accelerator is presented including external surveys during machine operation for personnel protection and for compliance with AEC requirements; internal surveys and activation studies, both for improved machine maintenance and for personnel protection from induced activity during machine shutdown; and target yield and angular distribution studies, and studies of shielding materials, for cyclotron development programs. (W.H.K.)

22038 (UCRL-19399) BEVATRON OPERATION AND DEVELOPMENT. 63. JULY-SEPTEMBER 1969. Crebbin, Kenneth C.; Evans, Don M. (California Univ., Berkeley. Lawrence Radiation Lab.). 21 Nov 1969. Contract W-7405-eng-48. 9p. Dep. CFSTI.

The Bevatron provided beam to 16 experiments this quarter and accelerated a total of 1.83×10^{18} protons. A new thin-septum magnet (0.130 in.) was installed in the east straight section of the first magnet in the EPB system. This magnet is compatible with the present energy-loss extraction system and will be used to continue resonant-extraction studies. A quadrupole magnet was also installed just downstream from this septum magnet. Extraction efficiency using the energy-loss system is now about 50%. Computer control of the external beam transport magnets was expanded to include control of more magnets and more versatile programming options. The control system was also expanded toward eventual control of the pulse modes of the Bevatron magnet power supply. (auth)

22039 (UCRL-19407) TRAJECTORY: AN ORBIT AND ION OPTIC MATRIX PROGRAM FOR THE 184-INCH CYCLOTRON. Paul, A. C. (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1969. Contract W-7405-eng-48. 17p. Dep. CFSTI.

TRAJECTORY is a Fortran IV program for simultaneously in-

tegrating the equations of motion of a charged particle in a magnetic field and the differential equations for the ion optic matrix representing small motion about the paraxial trajectory. The orbit calculation is carried out in the median plane with the vertical transformation matrix calculated from a Taylor-series expansion of the magnetic field off the median plane. The matrix so calculated is readily used with the ion-optic transport codes TRANSPORT or OPTIK. The trajectory data can be used to obtain internal target positioning for a given beam line. (auth)

22040 GENERATOARE DE NEUTRONI. PRINCIPII SI UTILIZARI. (Neutron Generators. Principles and Applications). Teodorescu, I. E. Bucuresti; Editura Academiei Republicii Socialiste Romania (1969). 358p.

Free neutrons are obtained by certain nuclear processes, such as fission and nuclear reactions. Fission processes occurring in nuclear reactors are not treated in the book because the generation of neutrons is considered secondary in that case. Devices which produce neutrons by charged-particle or proton induced reactions are widely used because of their small size and convenient operation. Those using radioactive materials as the source for the particles are called neutron sources. Neutrons are also generated in charged-particle accelerators either by the direct action of accelarated particles on the target material or by bremsstrahlung effects of accelerated electrons on an intermediate target, followed by a photonuclear reaction. Nuclear interactions resulting from the release of neutrons are systematically examined, reviewing devices in which practically useable neutron fluxes are generated, those creating primary and secondary particles, apparatus for controlling the bombarding and neutron beams, in order to control the spatial, energy or time distribution (collimators, moderators and pulsing systems), and recording devices. Shielding and personnel protection means are also treated, and the use of neutron beams for measurement and quality control of manufacture products is indicated. (TTT)

22041 DEVICE FOR PREPARING RADIOACTIVE KRYPTONATES BY ION BOMBARDMENT. Lukac, P. (Technical Univ., Bratislava). Radiochem. Radioanal. Lett.; 3: 121-7(12 Mar 1970).

A device for collective and quick production of radioactive kryptonates by ion bombardment is described. This device consists of an ion accelerator, sample changer, and dose device. The samples are bombarded with a mixture of ions of inactive krypton and its radioactive isotope ^{85}Kr. The accelerated ions attain a current density up to 50 $\mu A/cm^2$. The surface specific activity obtained is about 10^3 cpm/cm^2. The kryptonates produced in this way can be used for studying the surfaces of the solid phase. (auth)

22042 IONIZER FOR POLARIZED PROTON SOURCES. Coiffet, Philippe (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 270: 343-6(2 Feb 1970).

The principle of an ionizer for a beam of atomic hydrogen is presented. The polarization of protons is conserved during the storage. All the protons created can be injected into a pulsed accelerator. The ionization is produced by an electron beam of a few tens eV. The current peak could reach 10 μA. (France)

22043 PROSPECTIVE STUDIES OF ELEMENTARY PARTICLE INTERACTIONS IN ACCELERATORS. Komar, A. A. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 1544-56(Sep 1969). (In Russian).

Descriptions are given of electron and proton accelerators already in operation or under construction which were designed for perspective studies of elementary particles during the next 5 to 7 years. Special attention is paid to the development of colliding beam techniques. The perspective experimental goals which should be possible to achieve in the near future are discussed. (tr-auth)

22044 MEASUREMENT OF THE SPECTRAL DISTRIBUTION OF THE FRASCATI ELECTRON SYNCHROTRON RADIATION IN THE (80 TO 1200) A REGION. Balzarotti, A. (Univ., Rome); Piacentini, M.; Grandolfo, M. Lett. Nuovo Cim.; 3: 15-18(1 Jan 1970).

The first measurement of the spectral distribution of the light emitted in the wavelength range from 80 to 1200 Å by the Frascati electron synchrotron is reported, and preliminary results of the transmission of aluminum thin films in the region of the $L_{II,III}$ edge are given. (J.F.P.)

22045 STEADY-STATE MOTION OF A CHARGED-PARTICLE BEAM WITH ITS OWN SPACE CHARGE BEING TAKEN INTO ACCOUNT. Volkov, B. I.; Sveshnikov, A. G.; Semashko, N. N. (Moscow Univ.). Dokl. Akad. Nauk SSSR; 189: 984-6(11 Dec 1969). (In Russian).

A region T limited by a surface S of a right cylinder is defined. The base of the cylinder is a convex surface S_1 emitting a continuous stream of charged particles into the region T. The particles have a given distribution of velocities and current density at the emitter. Further the potential of the electric field E on the surface S and the potential of the magnetic field H are known. Equations are given for the trajectory and velocity of each beam particle. A numerical solution to the self-consistent axial-symmetric problem is obtained in the case of stationary movement by the use of iteration methods on a computer. It is possible to solve two types of problems: 1) determination of the charged-particle trajectories and the space distribution of potential in the stationary mode at given values of particle velocities and current density on the emitter, and 2) determination of the limiting current density. It turns out that in a series of cases a current density of 50 microamps/mm^2 disturbs focusing of a proton beam at a 10 kvolt slowing potential of the electrostatic field. These results can be used in designing various charged-particle injectors for accelerators and magnetic traps. (TTT)

22046 FOKUSIROVKA I RAZDELENIE PO MASSAM CHASTITS VYSOKIKH ENERGII. (Focusing and Mass Separation of High-Energy Particles). Kotov, V. I.; Miller, V. V. Moscow; Atomizdat (1969). 280p.

The contemporary methods of calculation and the adjustments of complex systems of quadrupole lenses and magnets in accelerator technology are discussed. The general theory of quadratic aberrations is presented, and the errors of doublet quadrupole lenses are analyzed. Also, the methods of obtaining pure beams with electrostatic and radiofrequency separators are described in detail. (tr-auth)

22047 PROGRESS REPORT ON THE 200-GeV ACCELERATOR OF THE NATIONAL ACCELERATOR LABORATORY. Read, A. Lincoln (National Accelerator Lab., Batavia, Ill. Univ. of Michigan, Ann Arbor). pp 247-77 of Proceedings of Boulder Conference on High Energy Physics. /Mahanthappa, K. T. (ed.). Boulder, Colo.; Colorado Associated University Press (1970).

From High Energy Physics Conference, Boulder, Colo. See CONF-690813.

A review is given of the principal design features of the 200-GeV accelerator and of the laboratory facilities to be built at the accelerator site. The current status of the design and construction work on the various component sub-accelerators which comprise the 200-GeV accelerator is discussed. A brief discussion is given of the plans which are being developed for experimental facilities and high-energy physics research at NAL. (auth)

22048 FOCUSING PROPERTIES OF ELECTRIC AND MAGNETIC QUADRUPOLE LENSES. Smith, D. L. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods; 79: 144-64(1970).

Expressions for focusing coefficients applicable to the interior regions (transverse fields) of electric and magnetic quadrupole lenses have been derived through third order. Also, a simple procedure for computing the first-order contributions of the fringing fields in realistic lenses is discussed. Realistic effects are taken fully into consideration. These results are applied to the specific problem of a medium-length magnetic quadrupole lens. The second-order contributions vanish in the interior as a result of the quadrupole symmetry, and the third-order terms are found to be considerably smaller than the first-order terms. It is concluded that the fucusing properties of a quadrupole lens are governed almost entirely by the strength and axial variation of the transverse field gradient. These lens properties can be measured quite easily. (auth)

22049 MAGNETIC FIELD OF dc COILS OF CYLINDRICAL CONFIGURATION. Danilov, V. I.; Ianovici, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods; 79: 29-42(1970).

Starting from the differential form of the Biot–Savart law, the expressions of the magnetic field components for three general types of dc coils of cylindrical configuration called respectively annular sectorial axial, radial, and toroidal solenoids are obtained. The determination is based on the supposition that a fine wire is used for setting up the coils. From these expressions it is easy to obtain as a particular case the magnetic field components for more simple cylindrical configurations as circular current loops, circular cylindrical coils, toroids, etc. (auth)

22050 A STUDY OF ION BEAMS PRODUCED BY A DUOPLASMATRON ION SOURCE. Ciuti, P. (Univ., Trieste, Italy). Nucl. Instrum. Methods; 79: 55-60(1970).

The behavior of He^+ and Ne^+ ion beams, extracted by a duoplasmatron ion source, is studied as a function of the gas pressure and the arc current in the source. Beam impurities are also detected, but the amount of He^{++} and Ne^{++} was not measured. In order to explain the experimental results, the ion balance of

the source plasma is carried out. Losses and production processes in the plasma, taking into account the magnetic field influence, are also considered. (auth)

22051 ON THE THEORY OF STOCHASTIC ACCELERATION OF HIGH-ENERGY PARTICLES IN CYCLIC ACCELERATORS. Puri, S. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 233: 358-67(1970).

The existing results on the theory of stochastic cyclic accelerators are extended using the methods of difference equations and random-walk theory. The theoretical guidelines provided should be sufficient to allow an evaluation of the feasibility of making a practical machine using the principle of stochastic acceleration. It is found that the average time required for the acceleration of a particle to its final energy is approximately one-third of that in the existing results. It is shown that the diffusion constant in energy space can be very simply expressed in terms of the mean-square voltage applied at the accelerator gap and the bandwidth of the applied-field spectrum for the practical case of interest. The required power input and the resistive input impedance for the accelerator are calculated taking particle losses into account. (auth)

22052 INFLUENCE OF THE CAVITY GAP LENGTH ON THE PHASE STABILITY OF MICROTRONS. Reich, Herbert; Loens, Klaus; Feist, Harald (Physikalisch-Technische Bundesanstalt, Brunswich). Z. Angew. Phys.; 28: 244-50(9 Jan 1970). (In German).

The magnitude of phase stable regions and, therefore, the beam current of microtrons is reduced by the transit time effect of the electrons passing the accelerating gap. High injection voltages can compensate for this effect. For two types of microtrons mostly used (a = 2 and 3, a = number of hf periods during the first orbit) stability diagrams obtained by numerical calculations are presented showing the effects of parameter variation. For values of the relation (gap length d/hf-wave length λ) ≤ 0.14 injection voltages of 60 kV are sufficient to compensate for the transit time effect. The phase stable capture region of a = 3 microtrons is nearly 20% smaller than that of a = 2 microtrons which is about 31°. The numerical results are confirmed, substantially, by measurements on the 5-MeV microtron of the PTB (a = 2, $d/\lambda = 0.1$). The experimental length of the phase stable region reaches nearly 20°, only. There is good agreement in the absolute values of the most favorable operation parameters. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstract 22040.

22053 (CEA-N-1255) THE PROGRAM ELF–NEUTRON. Gervaise, Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 32p. (In French). Dep. CFSTI (U. S. Sales Only).

The program ELF-NEUTRON makes it possible to study the propagation of neutrons in cylindrical and spherical geometries, using cross sections given by the AWRE tape. In the case of a cylindrical geometry, the external contour can be circular or polygonal, the limiting conditions at this contour being either a vacuum, or total reflection. The preparation of the cross sections, the study of the variance, and the drawing of the curves showing the cross sections and the spectra are obtained almost automatically using auxiliary programs. (auth)

22054 (GEAP–13537) USERS MANUAL FOR DOT2DB: A TWO-DIMENSIONAL MULTIGROUP DISCRETE ORDINATES TRANSPORT/DIFFUSION CODE WITH ANISOTROPIC SCATTERING. Protsik, R.; Leff, E. G. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Sep 1969. Contract AT(04-3)-189. 84p. Dep. CFSTI.

Instructions for the use of the DOT2DB program are presented. DOT2DB solos both the multigroup discrete ordinates transport and the multigroup diffusion equations with anisotropic scattering in two dimensions by iterative procedures. The program is in FORTRAN IV and is designed for the GE635 computer. (J.W.R.)

22055 (IA–1191 and Add.) HYBSHOV: A PROGRAM FOR SOLVING THE FEW-GROUP SPACE–TIME DEPENDENT DIFFUSION EQUATION WITH A HYBRID COMPUTER. A Preliminary Report. Saphier, D.; Yiftah, S. (Israel Atomic Energy Commission, Tel Aviv). May 1969. 176p. Dep. CFSTI (U. S. Sales Only).

A program for solving the space-time dependent diffusion equation with a hybrid computer has been set up for the E.A.I.-8900 hybrid system. The digital part of the program is written in FORTRAN IV, and the control and data transfer subroutines are in the machine language of the E.A.I.-8400 digital computer. The diffusion equation is solved for a slab reactor with 44 mesh points, 4 energy groups and 4 groups of delayed neutrons. The number of regions is 7. In each region different isotopic composition is assumed. The maximum number of isotopes for which the code can prepare mixtures is 10. This report describes the assumptions made in developing the equations, and the limitations and range of the present program. A detailed description of the code as well as the various options are presented. (auth)

22056 (JAERI–1181) EVALUATION OF THERMAL NEUTRON SCATTERING CROSS SECTIONS FOR REACTOR MODERATORS (SUMMARY REPORT). (Japan Atomic Energy Research Inst., Tokyo). Sep 1969. 108p. Dep. CFSTI (U. S. Sales Only).

This is a summary report of the evaluation work of thermal neutron scattering cross sections, which was performed during the years from 1965 to 1968 by members of the thermalization group of Japanese Nuclear Data Committee. The report consists of three parts: general description, evaluation, and basic research works. The evaluation was aimed to be complete within the incoherent approximation. The studies and evaluations of the coherent effect, the multiple scattering correction, and other related problems are also included in the report as a supplement. (auth)

22057 (JUL–587-FN) CALCULATION OF SIMPLE DIFFERENTIAL NEUTRON SCATTERING CROSS SECTIONS FOR H_2O BY THE GENERAL FREQUENCY SPECTRUM AND COMPARISON WITH MEASURED VALUES. Reichelt, K.; Maier, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Apr 1969. 20p. (In German). Dep. CFSTI (U. S. Sales Only).

By means of the Egelstaff–Schofield theory, the differential and integral neutron cross sections for water and the mean cosine of scattering are calculated and compared with experimental findings. Discrepancies between the two sets of data exceeded 10%. Mathematical formulation of the problem is developed, and possible reasons for the discrepancy between theory and experiments are explored. (H.B.G.)

22058 (JUL–602-FN) SPIN FLUCTUATIONS AND CRITICAL MAGNETIC SCATTERING OF NEUTRONS ON NICKEL. Stump, Norbert (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper-und Neutronenphysik). Jul 1969. 60p. (In German). Dep. CFSTI (U. S. Sales Only).

By means of elastic small-angle scattering of neutrons, the correlation range of spin fluctuations was measured near the Curie point of nickel. Three samples were studied: a single crystal; a polycrystal; and a strongly deformed polycrystal. The exponent describing the correlation range was found to be 0.66; the Curie point of the single-crystal sample was 351.3°C, in agreement with previously reported values. It was predicted theoretically that for ideal crystals, and for fixed impulse transfer, maximal scattering occurs at a temperature T_{MAX} that, in turn, is a function of impulse transfer. For the single-crystal sample, T_{MAX} was found to be independent of impulse transfer. For the two polycrystals, T_{MAX} showed a dependence on impulse transfer which was determined by the degree of deformation. Temperature dependence of spin wave stiffness was determined by measuring cut-off angles for spin waves. For 1°K, the experimental value was 106 MeV $Å^2$. Methods and results are depicted in twenty diagrams. (H.B.G.)

22059 (RPI–328–174) TIME DEPENDENT NEUTRON SPECTRA MEASUREMENTS IN H_2O. Menzel, J. H.; Slovacek, R. E.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). [1968]. Contract AT(30-1)-328. 52p. Dep. CFSTI.

Time-dependent neutron spectra in the center of an externally pulsed finite ($7.16 \times 25.02 \times 25.4$ cm^3) H_2O medium at 37.8°C were measured over an energy range 0.01 eV <E <0.25 eV and for times extending from approximately zero to 100 μsec after the pulse. Experimental results are presented in the form of the time behavior of neutrons at various energies (neutron life histories), time moments, neutron spectra at various times, the steady state spectrum, as well as the energy and velocity moments. The average velocity of the experimental spectrum at t = 23 μsec is within 2% of the average velocity corresponding to the asymptotic Maxwellian distribution. Due to spatial harmonics, the apparent exponential rate of decay determined from neutron life history curves for t >30 μsec is only three-fourths of that corresponding to the fundamental decay constant for the medium under investigation. The results of a harmonic analysis based on cadmium-covered gold foil activations along the three axes of the water slab are in complete agreement with the neutron life histories at the medium center for 40 μsec < t < 100 μsec and with spatially-dependent die-away measurements for 150 μsec < t < 900 μsec. Time-dependent diffusion theory calcutions using a 78-group Haywood-II hydrogen kernel and a mass-16 free gas oxygen kernel were performed with and without spatial harmonics. The results of the calculations indicate that the average velocity is within 2% of the asymptotic value after 16 μsec, less than the measured value. The agreement between experiment and calculation is however considerably better than had been obtained in the only previously published study; in that investigation time-dependent spectra measurements made on a large water medium indicated that the thermalization time was greater than 100 μsec. (auth)

22060 NUMERICAL SOLUTION OF THE TIME- AND SPACE-DEPENDENT MULTIGROUP NEUTRON DIFFUSION EQUATIONS. Rhyne, W. R.; Lapsley, A. C. (Univ. of Virginia, Charlottesville). Nucl. Sci. Eng.; 40: 91-100(Apr 1970).

A numerical method for the solution of the time- and space-dependent multigroup diffusion equations is presented. The method permits a significant reduction in the computer time required to solve these equations by substantially increasing the allowable time step size. In the point reactor case, a form of the method considerably simplifies the calculation by removing the explicit dependence on the generation time and the delayed-neutron terms. The space-time equations are transformed into the Laplace domain and after multiplication by a weighting function they are transformed back into the time domain. By appropriate choice of the weighting function the equations appear either as coupled convolution integrals, where numerically difficult (e.g., generation time and delayed neutron) terms have been canceled, or as coupled integral equations in the weighted residual form, which permits very large time steps to be taken. (auth)

22061 DIE-AWAY EXPERIMENTS TO MEASURE NEUTRON DIFFUSION PARAMETERS OF HEAVY WATER IN SPHERES. McGhee, B. W. (Georgia Inst. of Tech., Atlanta); Haroon, M. R.; Graham III, W. W. J. Brit. Nucl. Energy Soc.; 9: 48-54(Jan 1970).

Diffusion parameters of 99.53% pure D_2O contained in spheres were determined by least squares fitting to decay constants mea-

sured by the pulsed neutron source method. The buckling range investigated was 0.013 to 0.151 cm^{-2}. The asymptotic region was chosen by a channel dropping method and the averages of the decay constants over this region were used for the evaluation of diffusion parameters. Purity and temperature corrections were applied, and an iterative procedure to evaluate buckling was used. The results compare well with measurements carried out by others. Using a calculated value of λ_0 corresponding to the known purity of the D_2O, diffusion parameters for D_2O contained in spheres were found to be: $D_0 = 212 \pm 1 \times 10^3$ cm^2-s^{-1}, $C = 644 \pm 45 \times 10^3$ cm^4-s^{-1}, $F = 24 \pm 5 \times 10^5$ cm^6-s^{-1}. (auth) (UK)

22062 DEPOLARIZATION OF NEUTRONS PASSING THROUGH A FERROMAGNETIC. Maleev, S. V.; Ruban, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 58: 199-210(Jan 1970). (In Russian).

Depolarization of neutrons passing through a ferromagnetic sample in the saturated state is considered. The depolarization is caused by random magnetic fields produced by thermal motion of the atomic spins. In the most interesting case, when the neutron polarization is parallel to the external field, the depolarization is expressed in terms of the magnetization fluctuation correlator. It is shown that depolarization is determined by fluctuations averaged over the quantum indeterminancy of the neutron position in the beam; it thus strongly depends on the angular divergence of the beam and on its degree of monochromaticity. For a wide and nonmonochromatic beam the depolarization is proportional to the total cross section for inelastic magnetic scattering. Formulas for depolarization are derived on basis of spin wave theory and it is noted that an experimental study of depolarization should permit one to determine the main parameters of the theory. Depolarization in the critical region is discussed qualitatively. (auth)

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 22219 and 22221.

22063 (CCDN-NW-11) NEWSLETTER BULLETIN NO. 11. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). Oct 1969. 314p. Dep. CFSTI (U. S. Sales Only).

An updated index giving details of the content of the NNCSC/CCDN Experimental Neutron Data Library is presented. Information on reading the index and placing requests is given. (J.W.R.)

22064 (NP-18116) METHOD OF MEASUREMENT OF POLARIZATION. APPLICATION TO THE ELASTIC SCATTERING OF PROTONS ON ^3H AND ^3He. Frascaria, Robert (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 51p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

Proton double-scattering experiments were performed with a nonpolarized proton beam from a synchrocyclotron. In these experiments, the first scattering on a carbon target takes place in the deflection magnet, in order that the protons scattered at an angle θ could be directed toward the center of the reaction chamber. Then the polarized beam passes through a pair of quadrupolar lenses and two electrically independent solenoids to eliminate wrong asymmetries before reaching the reaction chamber. Characteristic features of the polarized proton beam obtained are given and the polarization produced on a second scattering carbon target is studied. Then, this polarized proton beam was used to measure the polarization in the elastic scattering of protons by ^3He and ^3H gaseous targets for lab angles between 11 and 50°. Results are in relatively good agreement with the theoretical calculation for polarization in the impulse approximation. If a certain percentage of S′ wave is included in the calculation, there is a good agreement up to 2% of S′. (France)

22065 VACUUM POLARIZATION AND D-WAVE $\alpha-\alpha$ SCATTERING. Kermode, M. W. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 47: 113-16(1 Jan 1969).

The D-wave phase shifts for $\alpha-\alpha$ scattering at low energies are obtained from (i) new analyses of the differential cross sections and (ii) the effects of vacuum polarization. The results are −0.4° (−0.4°), −0.2° (−0.4°), +0.2° (−0.4°), −0.2° (−0.2°), and 0.3° (0.2°) for the center-of-mass energies 0.3, 0.425, 0.5, 0.75, and 1.0 MeV, respectively. It is felt that these results are significant. (auth) (Canada)

22066 PHOTODISINTEGRATION OF ^4He. Ahmed, E. (Atomic Energy Centre, Dacca, Pakistan); Chowdhury, S. M. M. R.; Husain, D. Nucl. Phys.; A141: 664-6(1970).

The cross section for two-body photodisintegration of ^4He into deuterons was calculated using wave functions which give the correct binding energy and the radius of ^4He. The results are compared with the previous theoretical calculations as well as with the recent experiment of Del Bianco and Poutissou. It is found that the theoretical results are in good agreement with the experimental results. (auth)

22067 BETA DECAY OF TRITIUM. Daris, R.; St.-Pierre, C. (Univ. Laval, Quebec). Nucl. Phys.; A138: 545-55(1969).

Four tritium beta spectra were obtained with sources made of tritium adsorbed in Al foils. The effective source thickness is less than $2\mu g/cm^2$ of Al. The Th "F" and "A" (corrected for Doppler shift) lines were used for calibration. The experimental data were compared with computed spectra folded with the resolution curve determined from the "F" and "A" line profiles. The momentum resolution is 0.25%. The end-point of the β-spectrum is determined to be 18.570 ± 0.075 keV. This decay energy with a half-life of 12.43 y gives a ft value of 1130 ± 15 sec. The analysis of the upper 1 keV part of the spectra gives a probable rest mass of the neutrino $m_\nu = 0$ with an upper limit of 75 eV. (auth)

22068 EXCITED 0^+ LEVEL OF α PARTICLE. Narodetskii, I. M. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 31B: 143-5(2 Feb 1970).

Faddeev–Yakubovsky integral equations for four particles are applied to a calculation of excited states of the α particle. For an excited 0^+ level, the value of the binding energy is found to be 18.408 MeV. (auth)

22069 BINDING ENERGY OF THE ALPHA PARTICLE WITH TENSOR FORCES AND A VELOCITY-DEPENDENT POTENTIAL. Jain, S. C. (Allahabad Univ., India). Can. J. Phys.; 48: 7-8(1 Jan 1970).

The results of a variational calculation for the binding energy of the alpha particle with the tensor velocity-dependent potential of Werner and the Irving wave function, containing a mixture of the principal $^1S_0$ and $^5D_0^{(1)}$ states, are presented. A binding energy of 28.03 MeV for the alpha particle is found, which is in excellent agreement with experiments, but the r.m.s. radius obtained in this way is about 88% of the experimental value. (auth) (Canada)

22070 THREE-PARTICLE AND TOTAL PHOTODISINTEGRATION OF ^4He. Arkatov, Yu. M.; Bazaeva, A. V.; Vatset, P. I.; Voloshchuk, V. I.; Klyucharev, A. P.; Khodyachikh, A. F. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 10: 1123-9(1969). (In Russian).

Three-particle and total photodisintegration of ^4He was investigated by means of a diffusion chamber on an electron linear accelerator with the maximal γ-quanta energy of 120 MeV. Total cross sections for both the reactions are obtained as well as the angular distributions and the distributions on the relative energies of the products for the three-particle photodisintegration. For the three-particle reaction some new regularities are found in the behavior of the total cross section as a function of the γ-quanta energy. Two bumps are observed on the resonance curve. The first maximum is about 50 MeV, the second one is at 75 MeV. The corresponding cross sections are equal to 0.2 and 0.17 mbarn. (auth)

22071 QUASI-FREE SCATTERING IN THE D(p,pn)p REACTION FROM 15 TO 50 MeV. Petersen, E. L.; Allas, R. G.; Bondelid, R. O.; Pieper, A. G.; Theus, R. B. (Naval Research Lab., Washington, D. C.). Phys. Lett.; 31B: 209-10(16 Feb 1970).

The D(p,pn)p reaction was studied in a kinematically complete experiment. Comparison with the kinematically equivalent D(p,pp)n reaction shows the surprising result that the measured cross section for the (p,pn) reaction is a factor of seven larger than that of the (p,pp) reaction at the lower energies. The impulse approximation describes the shape of the observed energy spectra, but does not predict the measured magnitude. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 21013, 22063, 22200, and 22221.

22072 (CEA-CONF-1456) THE REACTION $^6Li(^6Li, \alpha)2\alpha$ BETWEEN 4 MeV AND 24 MeV EVIDENCE FOR A QUASI-MOLECULAR STATE ^6Li–^6Li. Frois, B.; Marquez, L.; Quebert, J. L.; Scheurer, J. N. (Bordeaux Univ., Gradignan (France).

Centre d'Etudes Nucleaires); Laugier, J. P. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes); Gruber, G.; Heinicke, E.; Meier-Ewert, K. (Heidelberg Univ. (West Germany). Physikalisches Institut (II)). [1968]. 7p. (CONF-690707-2). Dep. CFSTI (U. S. Sales Only).

From International Conference on Nuclear Reactions Induced by Heavy Ions, Heidelberg, Germany.

The reaction $^{6}Li(^{6}Li,\alpha)2\alpha$ was studied from 4 to 24 MeV incident energy. The experiment was carried out with a Van de Graaff EN Tandem. The target was made of a 20 $\mu g/cm^2$ ^{6}Li deposit on a 20 $\mu g/cm^2$ carbon backing. The beam was monitored with a Faraday cup. The alpha particles were registered by 10 solid-state detectors evenly spaced from 20 to 155° and for 14 different energies. The angular distributions and excitation functions of $^{6}Li(^{6}Li,\alpha)^{8}Be$ ground and first excited state were measured. This reaction had been previously studied at Saclay from 2 to 4 MeV. At these energies the spectra are dominated by a very broad peak. This peak was successfully explained as coming from the breakup of a quasimolecular state $^{8}Li-^{8}Li$. This hypothesis led to two predictions. The purpose of this work was to verify them. First, the peak should broaden and disappear as the incident energy increases. Secondly, the excitation function should show one wide resonance (or several) centered at the Coulomb barrier. The experiment has verified both predictions. (auth)

22073 (KFK-967) MEASUREMENT OF THE INELASTIC SCATTERING OF 104 MeV ALPHA PARTICLES AND THEIR DESCRIPTION BY THE AUSTERN-BLAIR THEORY. Specht, J.; Rebel, H.; Schatz, G.; Schweimer, G. W. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium); Hauser, G.; Loehken, R. (Heidelberg Univ. (West Germany). Physikalisches Institut (II)). May 1969. 29p. (In German). Dep. CFSTI (U. S. Sales Only).

Angular distribution of inelastically scattered alpha particles of 104 MeV was measured on carbon-12, neon-20, and nickel-64. Findings could be explained according to the theory of Austern and Blair by the assumption of excitations to the fifth order. From the measured and reduced matrix elements and under the assumption of a collective motion of the target nucleus, length of deformation could be obtained up to the 8th order. Excitation of the ^{12}C nucleus could be interpreted as surface vibration; excitation of the ^{20}Ne nucleus could be explained as rotation of a barrel-like configuration. (H.B.G.)

22074 (NP-18071) POLARIZATION MEASUREMENTS ON THE ELASTIC SCATTERING OF 52-MeV DEUTERONS ON CARBON WITH THE HELP OF A DOUBLE-SCATTERING EXPERIMENT. Weigele, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jul 1969. 51p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Karlsruhe, Ger.

Due to spin-dependency of nuclear forces, particles that originate from nuclear reactions or that are scattered by a nucleus are generally polarized. If these particles are subjected to a second scattering, the angular distribution will show an asymmetry. By measuring the parameters of asymmetry, the degree of polarization can be determined. At the Karlsruhe isochroncyclotron 52-MeV deuterons were polarized by scattering on carbon and the polarization determined by a subsequent scattering. Qualitatively, the experimental findings agreed with predictions derived from an optical model; however, quantitatively, considerable discrepancies existed. (tr-auth)

22075 (NYO-2771-36) NUCLEAR CHEMISTRY RESEARCH: RECOIL STUDIES OF NUCLEAR REACTIONS. Annual Report, January-December 1969. Wolke, Robert L. (Pittsburgh Univ., Pa. Wherrett Lab. of Nuclear Chemistry). Contract AT(30-1)-2771. 56p. Dep. CFSTI.

A recoil study of the $^{12}C(d,\alpha)$ ^{10}B reaction is reported. Progress in the development of targets for the recoil experiment is also reported. (J.W.R.)

22076 (SAL-11) STUDY OF PHOTONEUTRONS FROM ^{16}O, ^{12}C, AND ^{9}Be. Glavina, Corrado (Saskatchewan Univ., Saskatoon. Saskatchewan Accelerator Lab.). Jun 1968. 73p. Dep. CFSTI (U. S. Sales Only).

Thesis.

Photoneutron spectra and angular distributions from ^{16}O, ^{12}C, and ^{9}Be produced by $E_{\gamma max}$ = 103 MeV bremsstrahlung were measured. The spectra were obtained simultaneously at five angles by the time-of-flight technique. In the low-energy region (En < 15 MeV), corresponding to the giant resonance region of these nuclei, the energy of the major resonances observed in ^{12}C and ^{16}O agree with previous measurements. The angular distributions indicate that neutrons are primarily due to d-wave emission. The neutron spectrum from ^{9}Be shows no structure. The spectra of neutrons of En > 15 MeV show no structure for all nuclei investigated. The 90° yield decreases nearly exponentially with increasing energy. Neutrons are emitted preferentially at angles forward of 90° with respect to the incident photon direction. This forward peaking of the angular distribution is interpreted as being due to absorption of photons by clusters of nucleons in the nucleus. (auth)

22077 INVESTIGATION OF ^{16}O LEVELS BETWEEN 14- AND 21-MeV EXCITATION ENERGY BY INELASTIC ELECTRON SCATTERING. Stroetzel, M.; Goldmann, A. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 233: 245-59(1970). (In German).

The investigation of ^{16}O levels by electron scattering (60-MeV maximum energy) was continued up to the region of the giant resonance yielding spins, parities, transition probabilities, and transition radii for one E0 (14.00 MeV), four E1 (17.2, 19.0, 19.5 and 20.95 MeV), one M1 (16.21 MeV), two E2 (15.15 and 16.46 MeV), and two M2 (19.04 and 20.36 MeV) transitions. The behavior of one resonance at 18.5 MeV is not very well understood, and the spin and parity assignments of two other levels at 16.8 (3^+) and 17.6(2^-) MeV remain doubtful. Excitation energies and total widths as obtained from the experimental spectra are presented. (auth)

22078 COULOMB INTERACTION FOR J = $3/2^-$ LEVELS IN ^{9}Be AND ^{9}B. Tomaselli, M. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 233: 240-4(1970).

The Coulomb interaction is used to calculate energy shifts and mixing amplitudes of J = $3/2^-$, T = $1/2$ and $3/2$ states in ^{9}B and ^{9}Be. For the 14.39 MeV level in ^{9}Be, a neutron width of 0.15 keV is calculated from the T = $1/2$ admixtures in the wave function. (auth)

22079 $^{12}C(n,n)$, (n,n'), AND $(n,n')3\alpha$ REACTIONS AT 14.1 MeV. Grin, G. A.; Vaucher, B.; Alder, J. C.; Joseph, C. (Univ. of Lausanne, Switzerland). Helv. Phys. Acta; 42: 990-1002(30 Dec 1969).

The $^{12}C(n,n)$, (n,n'), and (n,n'), and $(n,n')3\alpha$ reactions were studied at 14.1 MeV by a time-of-flight method with a scintillating scatterer. The angular distributions and integrated cross sections were obtained for the following channels: Q = 0(0^+) and −4.43 MeV (2^+) for angles greater than 50°; Q = −7.66 MeV (0^+) (8.5 ± 2 mb), −9.63 MeV (3^-) (62.5 ± 5 mb), −10.1 MeV (0^+ or 2^+) (maximum 55 mb) and −10.84 MeV (1^-) (13−17 mb) over the whole angular range; −11.82 MeV (2^-) (3−7 mb) for angles smaller than 60°. At low scattered neutron energies a continuum was observed for which the cross section (≈100 mb, including the scattering to the broad level at 10.1 MeV) and the angular distribution were determined. (auth)

22080 THERMAL-NEUTRON-ABSORPTION CROSS SECTIONS OF ^{6}Li AND ^{10}B. Meadows, J. W.; Whalen, J. F. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 40: 12-16(Apr 1970).

The thermal-neutron-absorption cross sections of ^{6}Li and ^{10}B were measured by the pulsed-neutron method. The 2200 m/sec absorption cross sections are 938 ± 6 b for ^{6}Li and 3855 ± 26 b for ^{10}B. (auth)

22081 CROSS SECTION FOR THE DELAYED-NEUTRON YIELD FROM THE $^{17}O(n,p)^{17}N$ REACTION AT 14.1 MeV. Menlove, H. O.; Augustson, R. H.; Henry, C. N. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 40: 136-8(Apr 1970).

The absolute value of the cross section for the delayed-neutron yield from the $^{17}O(n,p)^{17}N$ reaction for 14.1-MeV neutrons was measured. The associated-particle technique was used to determine the absolute neutron flux from the $^{3}H(d,n)^{4}He$ reaction, and the delayed neutrons were detected using a calibrated flat-response detector. Samples of water highly enriched in ^{17}O were used for the irradiations. The weighted average of the measurements is $\sigma_{n,p}$ (activation) = 21.5 ± 1.7 mb. (L.T.W.)

22082 APPROXIMATE DISPERSION RELATIONS AND THE TOTAL COHERENT INELASTIC NEUTRON SCATTERING CROSS SECTION FOR GRAPHITE. Conn, Robert (EURATOM-CCR, Ispra, Italy). Nucl. Sci. Eng.; 40: 17-24(Apr 1970).

The total one-phonon coherent neutron scattering cross section for graphite is evaluated using an approximate model of the dispersion relations. A relatively simple phonon frequency distribution is derived and multiphonon terms are calculated in the incoherent approximation. The results are compared with experimental and other theoretical calculations based upon the incoherent approximation. The latter have been consistently lower than the experimental results by a factor of two or more. It is found that the out-of-plane or z-mode contributes ~75% of the one-phonon cross section. The value of $[\nu\Sigma_{0i}(\nu)]_{min}$ is found to be ~70% greater than the same quantity obtained with the same model in the incoherent approximation. Moreover, the λ-law or constant collision fre-

quency domain only begins with neutron wavelengths >~20 Å (the Bragg cutoff is 6.7 Å). (auth)

22083 INELASTIC SCATTERING OF 185 MeV PROTONS FROM ^{11}B, ^{12}C, AND ^{16}O. Sundberg, O.; Tibell, G. (Univ. of Uppsala). Ark. Fys.; 39: 397-410(Oct 1969).

The measurements on ^{11}B, ^{12}C and ^{16}O were done under improved experimental conditions and a considerable amount of new information was obtained. In the case of ^{11}B, several angular distributions were found to be forward peaked, making it possible to extract reduced transition probabilities for magnetic dipole transitions. In ^{12}C the angular distribution for the excitation of a 1-minus level at 10.78 MeV is deduced showing the predicted similarity of E1 and E3 angular distributions in inelastic proton scattering. A peak at an excitation energy of 14.05 MeV seems to be due to scattering from a state with spin-parity 4-plus. In the $^{16}O(p,p')$ reaction it is shown that at the proton energies studied the excitation of states at 6.92 MeV (2-plus) and 7.12 MeV (1-minus) occur. In most cases the errors in excitation energies and relative cross sections are considerably smaller than in the earlier report. Comparisons with theoretical predictions and other experiments are made. (auth) (SW)

22084 INELASTIC ELECTRON SCATTERING FROM THE 13 MeV REGION IN ^{16}O. Kim, J. C.; Singhal, R. P.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon). Can. J. Phys.; 48: 83-93(1 Jan 1970).

The cross section for the inelastic scattering of electrons from ^{16}O was measured at excitation energies between 11.5 and 13.25 MeV and momentum transfers between 0.45 and 0.9 fm^{-1}. This momentum transfer range bridges the gap between the previous high momentum transfer data of Bishop et al. and the low momentum transfer data of Stroetzel. The odd parity states are compared with the particle-hole predictions generated from Gillet's wave functions. The generalized Helm model fits the 11.5 MeV (2^+) level fairly well. An upper limit is set on the excitation of the magnetic monopole (0^-) level at 12.70 MeV. (auth) (Canada)

22085 LIFETIME OF THE 3.86-MeV STATE IN ^{13}C. Henson, S. H. (State Univ. of New York, Stony Brook); Fossan, D. B.; Paul, P.; Jones, K. W. Phys. Rev.; 188: 1967-8(20 Dec 1969).

The lifetime of the 3.86-MeV state in ^{13}C has been measured by the recoil-distance method using the $^{10}B(\alpha,p)^{13}C$ reaction. The value determined for the mean life is $\tau = 10.7 \pm 1$ psec. (auth)

22086 THE $^{16}O(d,n)^{17}F$ REACTION AT DEUTERON ENERGIES FROM 2.5 TO 5.5 MeV. Lodin, G.; Nilsson, L. (Aktiebolaget Atomenergi, Studsvik, Sweden). Z. Phys.; 233: 181-94(1970).

The $^{16}O(d,n)^{17}F$ transitions to the ground state and to the first excited state were studied in the deuteron energy range 2.5 to 5.5 MeV. Time-of-flight techniques and gas targets were used. Differential cross sections in the angular range 0 to 160° at deuteron energies from 3.0 to 5.5 MeV in steps of 0.5 MeV were recorded as well as yield curves at 0 and 30° from 2.5 to 5.5 MeV in steps of 100 keV. DWBA calculations using seven different deuteron optical potentials were performed. It is found that the spectroscopic factors depend strongly on the choice of deuteron optical potential. The ratio between the spectroscopic factors for the ground state and for the first excited state varies between 0.9 and 1.7 for various choices. The most straightforward choice gives the ratio 1.4. Similar studies at higher deuteron energies have yielded ratios close to unity. (auth)

22087 ELASTIC SCATTERING OF ALPHA PARTICLES FROM ^{12}C BETWEEN 19 AND 30 MeV. Morgan, James Fredrick. Minneapolis; Univ. of Minnesota (1968). 86p.

Thesis.

The elastic scattering of alpha particles from ^{12}C was measured as a function of both energy and angle from 18.90 and 30.06 MeV. Excitation functions were measured in 20 keV steps over this energy range at eight angles. Differential cross sections were then measured at the energies of the anomalies seen in the excitation functions. Neither the optical model nor the smooth cut-off model were capable of fitting the angular distribution. Although a phase shift analysis was capable of giving good fits to the individual differential cross sections, it was not possible to obtain a closed set of phase shifts over the entire energy range. A statistical analysis in terms of autocorrelation functions and cross correlations indicates that the reaction proceeds primarily through the overlapping levels of the compound nucleus with a coherence width Γ of 480 keV in the laboratory system. (Diss. Abstr. Int., B)

22088 ANOMALY IN COLLISIONS OF PROTONS WITH Be NUCLEUS NEAR THE THRESHOLD OF THE REACTION $^9Be(p,n)^9B$. Siksin, V. S.; Domoratskii, V. N.; Donetskov, L. V.; Voronin, A. N.; Novikov, M. M.; Kudryavtsev, A. N.; Batyshchev, G. D.; Tseshkovskaya, V. F. (Rostov State Univ., USSR). Yadern. Fiz.; 10: 1130-5(1969). (In Russian).

Elastic scattering of protons on Be nuclei and the neutron yield in the reaction $^9Be(p,n)^9B$ were investigated near the threshold of the reaction. Resonances in the elastic scattering at the angle of 70° and in the total cross section of the reaction were observed. The density of the resonances in the threshold region is high and they are very close to each other. Just at the threshold a narrow resonance peak was found in the total cross section of the reaction $^9Be(p,n)^9B$. The peak is evidently related to the S state of the neutron to the ^9B nucleus. The curve for the ratio σ/ν near the threshold has a resonance structure that is correlated with the resonance structure of the scattering cross section. Until now, the observed resonance structure cannot be theoretically interpreted. (auth)

22089 ENERGY-DEPENDENT MODEL t-MATRIX FOR (p,2p) REACTIONS. Karmon, O.; Deutchman, P. A. (Univ. of Idaho, Moscow). Phys. Lett.; 31B: 113-15(2 Feb 1970).

An energy-dependent t-matrix is proposed for (p,2p) reactions. The present model fits (p,p) elastic scattering at 90° and is used to calculate the angular distribution of the $^{12}C(p,2p)^{11}B$ reaction at 155 MeV. The energy-dependent t-matrix raises the distribution at higher angles. (auth)

22090 SPLITTING OF ^7Li NUCLEUS AT INELASTIC SCATTERING OF γ QUANTA. Denisov, V. P.; Komar, A. P.; Kulchitskii, L. A.; Chubukov, I. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 10: 1116-22(1969). (In Russian).

Inelastic scattering of γ quanta which is one of the poorly investigated processes, is studied on the reaction $^7Li(\gamma,\gamma')^7Li^* \rightarrow {}^4He + {}^3H$ as an example. When investigating phototritons from the ^7Li nucleus by means of the analysis of triton yield for narrow energy interval, a group of tritons with the production threshold between that of the reaction $(\gamma,t)-(2.46$ MeV) and $(\gamma,pt)-(22.28$ MeV), was found. Tritons with such production threshold may be related only to the reaction $(\gamma,\gamma't)$. The integral cross section of this reaction was found to be (1.1 ± 0.3) MeV · mbn for tritons with energies 3.5 to 10 MeV. Cross section of the reaction (γ,γ') was also investigated by means of direct registration of scattered γ quanta. In the γ quanta spectrum, peaks were observed at the energies 7.5, 8.4, and 9.5 MeV. (auth)

22091 TEST FOR THE SHELL-MODEL WEINBERG TREATMENT OF THE REACTION $^{15}N(p,p')^{15}N^*$ WITH A SEPARABLE INTERACTION. Poepel, Bertram; Schuette, Gerhard (Univ., Heidelberg). Z. Phys.; 231: 48-58(1970).

A modification of Weinberg's method in connection with the Born approximation was first employed by Ebenhöh et al. to describe the reaction $^{15}N(n,n')^{15}N^*$ using a delta-force as residual interaction. This method is now applied to the same reaction but using a surface-delta-interaction. For this separable interaction also the exact solution of the problem is presented. We were not interested in adjusting any parameters to obtain optimal agreement with experiment. Only the results of these two approaches are compared. The good agreement may give confidence in the application of the modified Weinberg method in connection with non-separable interactions.

22092 INVESTIGATION OF HIGH ENERGY ^8Li FRAGMENTS PRODUCED AT SPALLATION OF NUCLEI ^{12}C AND ^{27}Al BY PROTONS WITH ENERGY 660 MeV. Azimov, S. A.; Aripov, R.; Beter, E. V.; Gulyamov, U. G.; Igamberdiev, K.; Lozhkin, O. V. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 10: 1145-8(1969). (In Russian).

Differential energy spectra and angular distributions are obtained for high energy ($T \geq 30$ MeV) ^8Li fragments produced at spallation of ^{12}C and ^{27}Al nuclei by protons with energy 660 MeV. Production cross sections for these fragments are determined. The experimental data are compared with the cluster model of fragmentation. (auth)

22093 DWBA-CALCULATION OF THE AMPLITUDES OF RECTANGLE DIAGRAMS IN DIRECT NUCLEAR REACTIONS. Magzumov, E. Zh.; Neudatchin, V. G. (Moscow State Univ.). Phys. Lett.; 31B: 106-8(2 Feb 1970).

The differential cross sections of the (t,p) and (p,p') reactions realized on p-shell nuclei and described with the rectangle diagram are calculated. The DWBA with surface interaction is used. The results show that the form of angular distribution is invariant as compared to the case of the plane waves. The absolute value of the cross section decreases rapidly with increasing energy of the bombarding particle. (auth)

22094 ISOSPIN-NONCONSERVING PARTICLE DECAYS OF THE LOWEST $T = {}^3/_2$ LEVELS IN ^{17}F AND ^{17}O. McDonald, A. B.;

Adelberger, E. G.; Mak, H. B.; Ashery, D; Shukla, A. P.; Cocke, C. L.; Davids, C. N. (California Inst. of Tech., Pasadena). Phys. Lett.; 31B: 119-21(2 Feb 1970).

Branching ratios have been measured for the isospin-nonconserving particle decays of the lowest T = ³/₂ levels of ^{17}F and ^{17}O to the ground state and unresolved 6.05- and 6.13-MeV levels of ^{16}O. The ratios of the reduced widths for decay to the ^{16}O levels are found to be very different for the two mirror T = ³/₂ levels. (auth)

22095 STRUCTURE OF ^{16}O AND $^{17}O(p,d)^{16}O$ REACTION. Mendelson, R.; Hardy, J. C.; Cerny, J. (Univ. of California, Berkeley). Phys. Lett.; 31B: 126-8(2 Feb 1970).

The first significant disagreement with recent "exact" shell-model calculations occurs in $^{17}O(p,d)^{16}O$ at E_p = 31 MeV. The 4^+ level at 10.36 MeV has < 5% of its predicted intensity. Little $1p_{\frac{1}{2}}$ strength appears below 18 MeV excitation in agreement with the model. (auth)

22096 DE-EXCITATION γ-RAYS FOLLOWING PHOTODISINTEGRATION OF ^{14}N AND ^{32}S. Thompson, M. N.; Stewart, R. J. J.; Thompson, J. E. M. (Univ. of Melbourne). Phys. Lett.; 31B: 211-13(16 Feb 1970).

Cross sections, integrated to 29 MeV, are reported for the photodisintegration of ^{14}N and ^{32}S leading to excited states of the residual nuclei. The size of these cross sections provides strong evidence for the single-particle nature of the excitation process in the E1 giant resonance. (auth)

22097 MUON-CAPTURE IN ^{16}O-RENORMALIZATION OF THE ONE-BODY OPERATOR. Green, A. M. (Univ. of Helsinki. NORDITA, Copenhagen); Dahlblom, T. K.; Kallio, A.; Rho, M. Phys. Lett.; 31B: 189-91(16 Feb 1970).

A calculation of muon-capture rates in ^{16}O is made with a consistent treatment of operator renormalization, with results in good agreement with the experiments. (auth)

22098 ENERGIES OF MONOPOLE VIBRATIONS. Zamick, L. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett.; 31B: 160-2(16 Feb 1970).

The energies of the T = 0 and T = 1 monopole states in ^{16}O are calculated to second order in perturbation theory. Terms are found which more than cancel the R. P. A. graphs; these help to push up the energy of the T = 0 state. (auth)

22099 REALISTIC INTERACTION CALCULATIONS OF (p,n) REACTIONS INCLUDING TENSOR KNOCK-OUT AMPLITUDES. Love, W. G.; Parish, L. J.; Richter, A. (Florida State Univ., Tallahassee). Phys. Lett.; 31B: 167-70(16 Feb 1970).

The reactions $^{14}N(p,n)^{14}O$(g.s.) and $^{13}C(p,n)^{13}N$(g.s.) were studied using a realistic nucleon-nucleon interaction. A tensor force is included which has approximately the same momentum components as the triplet-even Hamada–Johnston potential truncated according to the Moszkowski–Scott prescription. Knock-out exchange contributions were investigated for both central and tensor forces. The tensor knock-out amplitudes were found to be important in the $^{14}N(p,n)^{14}O$(g.s.) transition. (auth)

22100 DETERMINATION OF EXCITATION ENERGY OF LEVELS AND INCIDENT BEAM ENERGY USING A MINIMUM CHI-SQUARED TECHNIQUE. Chang, C. C. (Univ. of Southern California, Los Angeles). Nucl. Instrum. Methods; 79: 129-33 (1970).

A minimum chi-squared technique, which fits the experimentally obtained peaks as the function of angle to the two-body nuclear reaction kinematics, is considered. Formulas which compute the excitation energy of various residual nucleus states are derived. This method was applied to the multi-particle transfer reactions on the p + ^{14}N reaction, and the excitation energies thus obtained for ^{13}N, ^{12}C, and ^{11}C agreed quite well with the accepted values. (auth)

22101 WORKING WITH POLARIZED NEUTRONS AT THE HIGH-FLUX REACTOR. Abrahams, K. Atoomenergie Haar Toepass.; 11: 308-10(Dec 1969). (In Dutch).

The apparatus and technique used for the measurement of spin values are described, illustrating the experimental arrangement for single and differential spectra of $^{40}Ar(n,\gamma)$. The thermal neutrons, focused by 7-m^2 reflecting magnetic mirrors, yielded a flux of 3×10^7 cm^{-2} sec^{-1} in a 10-cm^2 area of the Petten High Flux Reactor. The spin value of the (n,γ) radiation following the capture of the polarized neutrons was measured, using two polarization spectra of opposite sign. For a simple reaction, such as $^{40}Ar(d,p)^{41}Ar$, the spin values may be associated with the theoretical energy levels based on the shell model. (TTT)

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Refer also to abstracts 20842, 21009, 22063, 22073, 22092, 22096, 22147, 22196, and 22231.

22102 (MPIH–1968/5/5) PARTICLE–HOLE CONDITION IN THE Ca ISOTOPES. Santo, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). [1968]. 33p. (In German). (CONF-680461–5). Dep. CFSTI (U. S. Sales Only).

From Professional Commission on Nuclear Physics, Bad Neuenahr, Germany.

The $(^3He,\alpha)$, $(^3He,d)$, (d,p), (d,t), (p,d), (p,t), and (t,α) reactions on the even isotopes of Ca were studied in order to find and analyze transitions which are forbidden in the simple shell model and to obtain data on the type and magnitude of the deviations from the shell model. A DWBA analysis was performed and spectroscopic factors were extracted. The results of the stripping and pick-up experiments were reported. An extensive analysis of the results led to the interpretation of the states occurring as particle-hole states. The reactions are two nucleon transfer reactions, which have not been extensively studied. Preliminary results from such experiments for the (p,t) reactions were discussed and show the importance of accurate investigations of this reaction for better understanding of these nuclei. (J.S.R.)

22103 (ORNL-TM–2472) MEASUREMENTS OF (d,n) REACTIONS ON ^{58}Ni, ^{60}Ni, ^{62}Ni, AND ^{64}Ni AT 5 AND 10 MeV. Marusak, Alex L. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 133p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Absolute differential cross sections for $^{58}Ni(d,n)^{59}Cu$, $^{60}Ni(d,n)^{61}Cu$, $^{62}Ni(d,n)^{63}Cu$, and $^{64}Ni(d,n)^{65}Cu$ at 5 and 10 MeV were measured by time-of-flight techniques in order to obtain energy levels, l-values, and spectroscopic strengths for the odd-A copper isotopes, and to compare these results with those obtained from the $(^3He,d)$ and (α,t) proton stripping reactions. Angular distributions were compared with predictions of DWBA theory using optical model potentials of the Woods-Saxon form, taking into account nonlocality, spin-orbit terms, and finite-range effects in the (p,n) interaction. Optical model parameters were obtained from elastic scattering of deuterons on ^{60}Ni. Angular distributions predicted by DWBA analysis agreed well with the 10 MeV data but poorly with the 5 MeV data. Spectroscopic strengths were obtained for 14 levels in ^{59}Cu, 19 levels in ^{61}Cu, 10 levels in ^{63}Cu, and 9 levels in ^{65}Cu. Agreement with spectroscopic strengths obtained from $(^3He,d)$ measurements was good. Relative spectroscopic strengths of the first few low-lying levels in the odd-A copper isotopes are in marked disagreement with those predicted by the simple excited-core model, but in fair agreement with predictions of more extended models. (auth)

22104 OBSERVATION OF T = 4 STATES IN ^{46}Ca AND LEVEL STRUCTURE OF ^{46}K. Dupont, Y.; Martin, P.; Chabre, M. (Institut des Sciences Nucleaires, Grenoble, France). Phys. Lett.; 31B: 68-70(19 Jan 1970).

Seven levels in ^{46}K and their T = 4 analog states in ^{46}Ca were observed in the reactions $^{48}Ca(p,^3He)^{46}K$ and $^{48}Ca(p,t)^{46}Ca$. Spin assignments are made. (auth)

22105 PARTICLE–HOLE AND PARTICLE–PARTICLE INTERACTIONS IN THE MASS-90 REGION. Freed, N.; Rhodes, W. (Pennsylvania State Univ., University Park). Phys. Lett.; 31B: 45-8(19 Jan 1970).

States of $(g_{\frac{9}{2}}\nu)^{-1}(d_{\frac{5}{2}}\nu)$ and $(g_{\frac{9}{2}}\pi)(d_{\frac{5}{2}}\nu)$ are calculated using realistic interactions with inclusion of core polarization. Comparison is made to experimentally observed neutron particle-hole states in ^{88}Sr and ^{90}Zr and to particle-particle states in ^{90}Y and ^{92}Nb. (auth)

22106 A SEMI-EMPIRICAL TREATMENT OF NEUTRON EMISSION PROBABILITIES FROM DELAYED NEUTRON PRECURSORS. Amiel, S.; Feldstein, H. (Soreq Nuclear Research Centre, Yavne, Israel). Phys. Lett.; 31B: 59-60(19 Jan 1970).

A simple correlation based on semi-empirical considerations is derived between the neutron emission probabilities of delayed neutron precursors and the corresponding $Q_\beta - B_n$ values. A good fit is obtained between calculated and experimental values. Further support for this treatment is given by Karnaukhov's analysis of delayed proton data and the behavior of the β strength function. (auth)

22107 TARGET-SPIN DEPENDENCE OBSERVED IN 50 MeV ^3He ELASTIC SCATTERING. Hafele, J. C. (Oak Ridge National

Lab., Tenn. Washington Univ., St. Louis); Fulmer, C. B.; Kingston, F. G. Phys. Lett.; 31B: 17-19(5 Jan 1970).

Elastic scattering of 50-MeV ^{3}He ions from ^{59}Co (J = 7/2) and ^{60}Ni (J = 0) was measured over the angular range of 12° to 130°. A significant difference was observed in the large-angle scattering from the two targets. This is interpreted as arising from a target spin dependence in ^{3}He elastic scattering. (auth)

22108 OBSERVATION OF TARGET GROUND STATE CORRELATIONS IN THE (d,n) REACTIONS ON EVEN ARGON ISOTOPES. Fuchs, H.; Hagen, M.; Janetzki, U.; Maier, K.-H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett.; 31B: 14-16(5 Jan 1970).

The (d,n) reactions on ^{36,38,40}Ar have been studied with the time-of-flight technique at E_d = 5.6 MeV. The extracted spectroscopic factors indicate shell-model impurities of the order of 10% in the Ar ground states, and severe splitting of the $f_{7/2}$ and $p_{3/2}$ proton single-particle states in the K final nuclei. (auth)

22109 HIGH-RESOLUTION SPECTROSCOPY OF ^{84m}Rb AND ^{86m}Rb. Pathak, B. P.; Murty, K. S. N.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Z. Phys.; 233: 209-15(1970).

Gamma radiations from ^{84m}Rb and ^{86m}Rb, produced by (n,2n) reaction on ^{85}Rb and ^{87}Rb, respectively, were studied using a high-resolution Ge(Li) spectrometer. Gamma rays of 216.3 ± 0.25, 248.2 ± 0.25, and 464.5 ± 0.25 keV were found decaying with 20 min half-life and are assigned to ^{84m}Rb. A single gamma ray of 556.1 ± 0.25 keV was found to decay with 62 sec half-life and has been assigned to ^{86m}Rb. The results are incorporated into decay schemes for the two isomers. (auth)

22110 EXPERIMENTAL STUDY OF (^{3}He,α) REACTIONS ON 2s-1d AND 1$f_{7/2}$ NUCLEI. II. THE ^{31}P(^{3}He,α)^{30}P REACTION. Pellegrini, F.; Filosofo, I.; Gentilin, F. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua. Laboratori Nazionali di Legnaro, Padua). Nuovo Cim. 65A: 311-17(21 Jan 1970).

Angular distributions for the ^{31}P(^{3}He,α)^{30}P reaction induced by 10-MeV ^{3}He particles were measured. Experimental evidence was found that the 3^+ (T = 0) states at 2.54 and 1.98 MeV excitation energy and the 2^+ (T = 0) 1.46 MeV state arise from the excitation of the ^{28}Si core. The other state up to an excitation energy of 3 MeV is well described by the $2s_{1/2}$-$1d_{3/2}$ configuration. (auth)

22111 EXPERIMENTAL STUDY OF (^{3}He,α) REACTIONS ON 2s-1d AND 1$f_{7/2}$ NUCLEI. III. (^{3}He,α) REACTIONS ON EVEN CALCIUM ISOTOPES. Pellegrini, F.; Ricci, R. A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua. Laboratori Nazionali di Legnaro, Padua). Nuovo Cim. 65A: 318-25(21 Jan 1970).

The ^{44}Ca(^{3}He,α)^{43}Ca and ^{48}Ca(^{3}He,α)^{47}Ca reactions were investigated in order to confirm the presence of core-excitation components in the ground state of the even calcium isotopes. The angular distributions of the outgoing α particles and absolute cross sections for different l-transitions were measured. (auth)

22112 EXPERIMENTAL STUDY OF (^{3}He,α) REACTIONS ON 2s-1d AND 1$f_{7/2}$ NUCLEI. I. (^{3}He,α) REACTION ON SILICON ISOTOPES. Pellegrini, F. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua. Laboratori Nazionali di Legnaro, Padua); Filosofo, I.; Gentilin, F.; Scotoni, I.; Gabrielli, I. Nuovo Cim. 65A: 297-310(21 Jan 1970).

Angular distribution for ^{28}Si(^{3}He,α)^{27}Si and ^{30}Si(^{3}He,α)^{29}Si reactions induced by 10-MeV ^{3}He particles were measured. Experimental evidence was found that the silicon isotopes contain in their ground state large core-excited components. Neutron occupation numbers for $d_{5/2}$, $d_{3/2}$, $s_{1/2}$ and $f_{7/2}$ orbits are obtained for the ground state of the silicon isotopes and compared with the shell-model prediction. (auth)

22113 SPIN CUT-OFF FACTORS AND THE INDEPENDENT-PAIRING MODEL. Rao, A. Lakshmana; Tirumala Rao, B. V.; Prasad, P. Rama; Rama Rao, J. (Andhra Univ., Waltair, India). Nuovo Cim., B; 65: 100-6(11 Jan 1970).

A brief résumé of the various models used for the description of the nuclear-level density and the relevant expressions for the calculation of the spin cut-off factor σ based on each of these models are presented. The experimental values of the isomeric ratios in the reactions ^{68}Zn(n,γ)^{69}Zn, ^{79}Br(n,γ)^{80}Br, ^{80}Se(n,γ)^{81}Se, ^{115}In(n,γ)^{116}In and ^{130}Te(n,γ)^{131}Te at 24 keV neutron energy reported in literature are used to extract the spin cut-off factors for the isotopes ^{69}Zn, ^{80}Br, ^{81}Se, ^{116}In, and ^{131}Te. The values of σ predicted by the independent-pairing model are found to be nearest to these experimental values. (auth)

22114 OBSERVATION OF THE 2159-keV LEVEL IN ^{60}Ni FOLLOWING THE BETA DECAY OF ^{60}Co. Dixon, W. R.; Storey, R. S. (National Research Council of Canada, Ottawa). Can. J. Phys.; 48: 483-8(1 Mar 1970). (NRCC-11089).

A search was made with a Ge(Li) detector for weak gamma-ray transitions in ^{60}Ni following the beta decay of ^{60}Co. Observation of a gamma ray of energy 2158.8 ± 0.4 keV and intensity of about 10^{-5} per disintegration has confirmed that the 2159-keV level of ^{60}Ni is populated in about 10^{-4} of the disintegrations. A much stronger peak at 822 keV was shown to be the single-escape peak of the 1332-keV gamma ray rather than the (2159 → 1332) transition as claimed by Hansen and Spernol. The search for other weak gamma rays in ^{60}Ni was inconclusive, and the mechanism for feeding the 2159-keV level is not clear. As a byproduct of this investigation, the energy of the first excited state of ^{64}Ni is found to be 1345.9 ± 0.3 keV. (auth) (Canada)

22115 PROPERTIES OF THE 2.645, 2.693, 3.001, AND 3.162 MeV LEVELS IN ^{35}Cl. Taras, P.; Matas, J. (Univ. of Montreal). Can. J. Phys.; 48: 603-15(1 Mar 1970).

Angular distributions and linear polarizations of the gamma rays emitted in the ^{35}Cl(p,p'γ)^{35}Cl reaction were measured. Four resonances were investigated at proton energies of 4.24, 4.82, 5.08, and 5.11 MeV. The spin and parity of the levels at 2.645, 2.693, and 3.001 MeV in ^{35}Cl were deduced to be $7/2^+$, $3/2^+$, respectively, while the spin and parity of the 3.162 MeV level were confirmed to be $7/2^-$. The multipolarity mixing ratios of the decay of these four levels to the ground state were found to be δ(M3/E2) = 0, δ(E2/M1) = +0.26 ± 0.03, δ(E2=M1) = +0.07 ± 0.02, and δ(E3/M2) = −0.25 ± 0.04, respectively. In addition, the branching ratios for the decay of these four levels were determined. (auth) (Canada)

22116 A STUDY OF THE ELASTIC AND INELASTIC SCATTERING OF PROTONS BY ^{40}Ca. Duval, Joseph Step81 Houston, Tex., Rice Univ. (1969). 174p.

Angular distributions of the elastic protons and the inelastic protons which leave the target nucleus in its ground state and first four excited states were measured in the range of proton energies from 8.0 to 12.5 MeV at 50 keV intervals with an experimental resolution of 30 to 50 keV. The total reaction cross section for the inelastic scattering of protons by ^{40}Ca was also measured. The elastic angular distributions and total reaction cross sections were analyzed by the method of phase shift analysis. The results of the phase shift analysis show evidence for narrow $s_{1/2}$ resonances at excitation energies in ^{41}Sc at E_{ex} ~ 10.313, 10.583, 10.813, and 10.963 MeV, $p_{3/2}$ resonances at E_{ex} ~ 9.583 and 9.963 MeV, and $d_{3/2}$ resonances at E_{ex} ~ 10.383, 10.613, and 12.683 MeV. In addition there is evidence for broad anomalies in the $s_{1/2}$, $d_{5/2}$, and $d_{3/2}$ partial waves. The $s_{1/2}$ anomaly is centered at E_{ex} ~ 11.583 MeV with a reduced width γ^2 ~ 1.01 MeV which is 44.5% of the single particle limit. The widths of the $d_{5/2}$ and $d_{3/2}$ anomalies have been estimated to be Γ ~ 1.0 to 2.0 MeV which gives reduced widths that are 10 to 20% of the single particle limit. The centers of the d-wave anomalies are at E_{ex} > 13.5 MeV. (Diss. Abstr. Int., B)

22117 INELASTIC SCATTERING OF 40-MeV PROTONS BY ^{58}Ni AND ^{60}Ni AND COUPLED CHANNEL ANALYSIS. Lingappa, Nanjappa. Minneapolis; Univ. of Minnesota (1969). 115p. Thesis.

Data from the inelastic scattering of 40-MeV protons by ^{58}Ni and ^{60}Ni are presented and analyzed in terms of a coupled-channels approach. Previous discrepancies between the experimental and theoretical (2^+) first excited state distributions are removed. The nature of coupled-channel calculations at this energy are discussed, with reference to absorptive strengths and form factors; the 4^+ states around 2.5-MeV excitation are shown to require one-phonon mixing in order to be able to explain the observed cross sections. Spin-parity assignments are given for states at 3.2 MeV, 5.1 MeV and 6.1 MeV excitation in ^{60}Ni, which have not been studied before in proton inelastic scattering at this energy. (Diss. Abstr. Int., B)

22118 SHELL-MODEL CALCULATIONS ON NEGATIVE-PARITY LEVELS IN A = 35, 37, AND 39 NUCLEI. Maripuu, S.; Hokken, G. A. (Univ., Utrecht). Nucl. Phys.; A141: 481-96 (1970).

Shell-model calculations of negative-parity states in ^{35}Cl, ^{35}S, ^{37}Cl, ^{39}Ar, and ^{39}K were performed by assuming an inert ^{32}S core with the residual interaction taking place within $1d\frac{n}{2}1f_{7/2}$ and $1d\frac{n}{2}2p_{3/2}$ configurations (with n = 2, 4, or 6). For the effective two-body interaction the modified surface delta interaction (MSDI) was used. The MSDI interaction parameters as well as the single-particle binding energies have been deduced from a least-squares fit to experimentally known levels in A = 35, 37 and 39 nuclei. Excitation energies, M1 and E2 transition strengths, gamma-ray branching ratios, magnetic dipole moments, spectroscopic factors and log ft values for allowed β-decay were calculated. Where comparison with experimental values is possible, the agreement is reasonable. The calculated strengths of the strong analog to anti-

analog M1 transitions are in excellent agreement with recent experimental results for ^{35}Cl and ^{37}Cl, whereas a discrepancy exists for ^{39}K. (auth)

22119 INELASTIC SCATTERING OF POLARIZED PROTONS ON ^{28}Si. Heinrich, G.; Hentschel, E. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A141: 551-60(1970).

The scattering of polarized protons on ^{28}Si was investigated at $E_p = 6.31$ MeV, where over a rather broad energy region only s-wave resonances with $J^\pi = \frac{1}{2}^+$ occur. The analyzing power from the excitation of the first 2^+ level is very similar to results obtained at 20 to 50 MeV energy, where the direct reaction mechanism is expected to dominate. By measuring the differential cross sections of the elastic and inelastic ($Q = -1.77$ MeV) channels at 6.33 MeV energy a significant effect of the compound part was found. From these facts one may conclude that the interference between the direct and compound reaction part has only a small effect on the analyzing power. (auth)

22120 INELASTIC SCATTERING OF 60-MeV ELECTRONS FROM ^{39}K. Peterson, R. J. (Yale Univ., New Haven); Theissen, H.; Alston, W. J. Nucl. Phys.; A143: 337-50(1970).

The inelastic scattering of electrons from ^{39}K is studied at a bombarding energy of 60.2 MeV, with angular distributions measured for seven transitions below an excitation energy of 5.5 MeV. Comparison with DWBA predictions permits the extraction of the electromagnetic transition strengths B(EL). The results are compared with those of heavy-particle scattering studies. The results for shell-model and collective-model transition operators in the electron scattering DWBA analysis are examined. (auth)

22121 RADIOACTIVE DECAY OF ^{83}Kr. Fiser, M.; Kristak, J. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett.; 3: 135-43(12 Mar 1970).

The radioactive decay of ^{83}Kr was studied by means of a lithium drifted germanium detector. Energies and relative intensities of 35 γ-transitions were determined. The lines 220.9, 356.4, 497.8, 586.0, and 904.1 keV were used for the estimation of the half-life of ^{83}Kr: 3.07 ± 0.08 min. (auth)

22122 DECAY OF THE ^{40}Ca 3.90-MeV STATE. Canada, T. R.; Cox, R. S.; Duval, J. S.; Sinex, C. H.; Class, C. M. (Rice Univ., Houston, Tex.). Phys. Rev.; 188: 1741-4(20 Dec 1969).

The branching ratio of the radiations emitted in the decay of the 3.90-MeV state of ^{40}Ca, $R = [3.90(2^+) \rightarrow 3.35(0^+)]/[3.90(2^+) \rightarrow 0(0^+)]$ has been measured to be $(8.7 \pm 1.4) \times 10^{-4}$, a value which is approximately 3 times larger than an earlier upper limit. The corresponding reduced transition probability is compared with a recent theoretical estimate. (auth)

22123 7416-keV 2^+ LEVEL IN ^{28}Si AND AN EXCITED PROLATE ROTATIONAL BAND. Gibson, E. F.; Goswami, A.; Huang, F.; McDaniels, D. K. (Univ. of Oregon, Eugene). Phys. Rev.; 188: 1965-7(20 Dec 1969).

γ-ray coincidence measurements revealed decay modes of the 7416.2$^+$ level in ^{28}Si to the 0^+ level at 4975 keV (6.3 ± 2.7)% and to the 2^+ level at 1779 keV (4.4 ± 2.3)%. The existence of an excited prolate rotational band in ^{28}Si based on either the 4975- or 6691-keV 0^+ states with the 7416-keV level as the 2^+ member has been ruled out on the basis of lifetime and branching-ratio data. (auth)

22124 MECHANISMS OF THE REACTIONS ^{63}Cu(p,n)^{63}Zn AND ^{63}Cu(p,2n)^{62}Zn AT 1.0 GeV. Remsberg, L. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev.; 188: 1703-6(20 Dec 1969).

Angular distributions of the recoil nuclei from the reactions ^{63}Cu(p,n)^{63}Zn and ^{63}Cu(p,2n)^{62}Zn, measured at an incident-proton energy of 1 GeV, were found in both cases to consist of a peak at an angle of 80°, and an approximately flat continuum in the forward direction. The peaks, which account for about $\frac{2}{3}$ of the total cross sections, are attributed to charge-exchange scattering in the case of the (p,n) reaction and charge-exchange scattering followed by neutron evaporation in the case of the (p,2n) reaction. The forward continua are attributed to analogous mechanisms involving $(P,P\pi^-)$ cascades, with and without subsequent neutron evaporation. This analysis is based primarily on the kinematics of the reactions, and the general relationships among angular distributions, kinematics, and mechanisms of simple nuclear reactions at high energies are discussed. (auth)

22125 LIFETIMES OF EXCITED STATES IN ^{56}Fe. Seaman, G. G. (Rutgers-The State Univ., New Brunswick, N. J.); Benczer-Koller, N.; Bertin, M. C.; MacDonald, Jack R. Phys. Rev.; 188: 1706-10(20 Dec 1969).

The mean lifetimes of excited states up to 4-MeV excitation energy in ^{56}Fe have been measured by the Doppler-shift-attenuation method. The excited states were populated by inelastic proton scattering at incident proton energies of 7.8 to 8.3 MeV. ^{56}Fe recoil energies and directions were defined by measuring γ rays in coincidence with protons backscattered into an annular detector. Reduced matrix elements are extracted for deexcitations of known multipolarity. (auth)

22126 HIGH-ENERGY GAMMA RAYS FROM THE DECAY OF ^{24}Na AND THE ^{27}Al(n,α)^{24}Na REACTION AT $E_n = 14$ MeV. Lebowitz, J. (Brooklyn Coll.); Sayres, A. R.; Trail, C. C.; Weber, B.; Zirkind, P. Nuovo Cim.; 65A: 675-82(21 Feb 1970).

The energy of the gamma-ray from the 5.2-MeV level in ^{24}Mg is found to be (3867.43 ± 0.30)keV and its intensity is $(4.89 \pm 0.25) \cdot 10^{-4}$ relative to that of the 2.75-MeV gamma-ray. No gamma in the 4.1 to 4.2 MeV region was found with $\frac{1}{15}$ the intensity of the 3.87-MeV line. The ^{27}Al(n,α)^{24}Na reaction cross section was found to be (110 ± 20) mb at $E_n = 14.7$ MeV. The absolute value depends upon the ^{19}F(n,2n)^{18}F cross section. (auth)

22127 NEUTRON RESONANCE OF ^{59}Co AT 132 eV. Nakajima, Yutaka; Ohkubo, Makio; Asami, Akira; Fuketa, Toyojiro (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo); 7: 7-12(Jan 1970).

Neutron transmission measurements on ^{59}Co were made for neutron energies from 0.8 eV to 3 keV using the time-of-flight spectrometer of a linear accelerator. The maximum time resolution was 10 nsec/m. Resonance parameters of the 132-eV resonance of ^{59}Co were determined from the neutron transmissions of several samples of different thicknesses by the thick-thin method, using an area analysis method based on the Breit-Wigner single-level formula. The following results were obtained, $E_0 = 132.0 \pm 0.5$ eV, $\Gamma = 6.0 \pm 0.2$ eV, $\Gamma_n = 5.15 \pm 0.06$ eV and $J = 4$. The value of the potential scattering radius, obtained from the transmission of the thickest sample, was $R' = 5.3 \pm 0.5$ fm. (auth)

22128 LIFETIME MEASUREMENTS OF THE 748 AND THE 776-keV LEVEL IN ^{51}Cr. Haar, W.; Richter, F. W. (Univ., Marburg, Ger.). Z. Phys.; 231: 1-9(1970). (In German).

Using the γ-radiation of 748 and 28 keV the half-lives of the first two excited states in ^{51}Cr at 748 and 776 keV were measured by a pulsed beam technique. The interesting states were populated by the reaction ^{51}V(p,nγ)^{51}Cr at 4 MeV proton energy. The half-lives were found to be $T_{\frac{1}{2}}(^{51}$Cr, 748 keV) = (7.35 ± 0.03) ns and $T_{\frac{1}{2}}(^{51}$Cr, 776 keV) = (5.53 ± 0.07) ns. The influence of the 28-keV transition between the two levels upon the lifetime of the 748-keV state was investigated. The 776 keV-state populates the 748 keV state only by 8.4%. The lifetime of the 776 keV state, therefore, cannot account for the anomalous long lifetime of the level at 748 keV as has been proposed by Bartholomew et al. (auth)

22129 K-HARMONICS METHOD IN jj REPRESENTATION CALCULATION OF ^{12}C NUCLEUS. Rybachenko, V. F.; Sadovoi, A. A.; Chulkov, N. M. Yadern. Fiz.; 10: 1156-65(1969). (In Russian).

The method of harmonic polynomials developed for the LS coupling applying to general case of arbitrary number of particles is given in the scheme of jj coupling. The formulas for the matrix elements from central, tensor, and spin-orbital interactions are given. The C^{12} nucleus is calculated for several sets of parameters of the potential with an account of tensor forces. (auth)

22130 STUDIES OF MIRROR NUCLEI OF THE SHELL $1f_{\frac{7}{2}}$. Vasil'ev, S. S.; Kolesnikov, N. N.; Shavtvalov, L. Ya. Vestn. Mosk. Univ., Ser. III, Fiz. Astron.; No. 5, 3-10(Sep-Oct 1969). (In Russian).

Studies were made of the β^+ spectra and half-life of ^{43}Ti. The upper boundary of the β^+ spectrum was equal to $E_\beta = 5.8 \pm 0.04$ MeV and half-life $T_{\frac{1}{2}} = 0.54 \pm 0.01$ sec. Data are presented on classification of various Coulomb energies of analog states of adjacent isobar nuclei. (R.V.J.)

22131 INVESTIGATION OF REACTIONS ^{62}Ni(d,p)^{63}Ni AND ^{66}Zn(d,p)^{67}Zn IN THE ENERGY REGION 2.4 TO 4.0 MeV. Zabegai, V. M.; Melenevskii, A. E.; Nemets, O. F.; Nemykin, V. I. (Inst. of Physics, Kiev). Yadern. Fiz.; 10: 1136-44(1969). (In Russian).

Excitation functions and angular distributions are investigated for ten groups of protons from the ^{62}Ni(d,p)^{63}Ni reactions and for six groups from the ^{66}Zn(d,p)^{67}Zn reaction. Comparing the experimental angular distributions with those calculated on the basis of the distorted-wave method, the spectroscopic factors were obtained. Possibilities to determine the exact values of the reduced widths for a number of levels are estimated. (auth)

22132 CROSS-SHELL TRANSITIONS IN THE (^{3}He,t) REACTION. Schwartz, J. J.; Watson, B. A. (Stanford Univ., Calif.). Phys. Lett.; 31B: 198-200(16 Feb 1970).

A study of the (^{3}He,t) reactions on ^{39}K and ^{41}K indicates that there is no general selection rule against cross-shell transitions in the (^{3}He,t) reaction, i.e., that charge exchange transitions between inequivalent orbits are in some cases comparable in strength with those between equivalent orbits. (auth)

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Refer also to abstracts 20727, 20742, 20981, 20994, 21001, 21554, 22063, 22105, 22113, 22222, 22228, 22235, and 22500–22502.

22133 (ANL–7636) FAST-NEUTRON TOTAL AND SCATTERING CROSS SECTIONS OF BISMUTH. Smith, A. B.; Whalen, J. F. (Argonne National Lab., Ill.); Barnard, E.; de Villiers, J. A. M.; Reitmann, D. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Nov 1969. Contract W-31-109-eng-38. 32p. Dep. CFSTI.

Total neutron cross sections of bismuth were measured with resolutions of ≳1 keV over the energy range 0.2 to 1.4 MeV. Differential elastic scattering cross sections were determined at intervals <50 keV from 0.3 to 1.5 MeV with resolutions of ~20 keV. The inelastic neutron excitation of a state of 896 ± 1 keV was observed, and the respective differential excitation cross sections determined with incident resolutions of ≳10 keV. Partially resolved resonance structure was evident in all the measured values. The experimental results were assayed for possible intermediate structure and were compared with the results of optical-model and statistical calculations. The model calculations were cognizant of the fluctuation and correlation of compound-nucleus resonance widths and of the shell closure at N = 126. (auth)

22134 (BNL–tr–322) NEUTRON RESONANCES OF GADOLINIUM ISOTOPES. Karzhavina, E. N.; Nguyen Nguyen Phong; Popov, A. B. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 9: 897-905(1969). 18p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 40053.

22135 (CEA–N–1149) STUDY OF SOME PROPERTIES OF EXCITED LEVELS OF THE COMPOUND NUCLEI FORMED BY THE INTERACTION OF SLOW NEUTRONS WITH ^{103}Rh, Xe, ^{155}Gd, ^{157}Gd, AND ^{232}Th. Ribon, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1969. 275p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

The scattering and total neutron cross sections for the above mentioned nuclei were measured up to about 4 keV (up to 200 eV for gadolinium isotopes) by the time-of-flight method. Parameters of several hundred resonances were determined, using the technique of shape-analysis, and the average values of strength functions radiation width and average level spacing were deduced from them. Experimental distributions of these parameters are generally in good agreement with theoretical laws. Some disagreements concerning the neutron reduced width distribution seem significant. (auth)(France)

22136 (CEA–R–3923) SPECTRAL SHAPES AND ANALYSIS OF SOME ONCE-FORBIDDEN BETA TRANSITIONS. Liaud, Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan 1970. 111p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

Spectral shapes of the once-forbidden beta transitions $1^- \rightarrow 2^+$ were measured for ^{170}Tm → ^{170}Yb, ^{186}Re → ^{186}Os and ^{188}Re → ^{188}Os, using a $\beta - \gamma$ coincidence system with a time-amplitude converter. Spectral shapes of the $1^- \rightarrow 0^+$ transitions leading to the fundamental levels of ^{170}Yb, ^{186}Os and ^{188}Os were obtained by a subtraction method. Nuclear matrix elements of these transitions were determined and compared with those calculated in the Nilsson-model framework. The ratio $(\int \overline{1\alpha} / \int \overline{1})$ was compared with various theoretical evaluations and was found in complete disagreement with the value obtained from the conserved vector current theory. Spectral shapes of the once-forbidden transitions $0^- \rightarrow 2^+$ and $0^- \rightarrow 0^+$ of ^{166}Ho were also measured. The deviation of the spectrum shape of the transition $0^- \rightarrow 2^+$ from that of unique transitions is interpreted with the help of Buhring's theory which gives the variation of lepton radial wave functions on the nuclear volume. (auth) (France)

22137 (CONF–690461–3) THE DECAY OF THE 3.2-hr CADMIUM-117m AND 2.4-hr CADMIUM-117g. Kiefer, W.; Herrmann, G. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie); Hageboe, E.; Patzelt, P. (European Organization for Nuclear Research, Geneva (Switzerland)). [1968]. 8p. (In German). Dep. CFSTI (U. S. Sales Only).

From Professional Commission on Nuclear Physics, Bad Neuenahr, Germany.

The decay of two isomeric isotopes of ^{117}Cd, produced by thermal reactions with ^{116}Cd and by spallation of Sn with 18-GeV protons followed by electromagnetic isotope separation, was studied. In the samples produced by the (n,γ) reaction the half lives of all γ lines with more than 1% relative frequency were determined and the lines were assigned to the isomers. The assignments were based on the variation of the relative frequences in the samples produced by tin spallation. The decay scheme of the 2.5-hr ^{117g}Cd with spin and parity of $\frac{1}{2}^+$ is given. The decay scheme of the 3.2-hr ^{117m}Cd ($\frac{11}{2}^-$) is also given. All γ transitions in the g isomer, with two exceptions, lead to ^{117m}In ($\frac{1}{2}^-$); in the m isomer all these transitions lead to ^{117g}In ($\frac{9}{2}^+$). A possible evaluation of the ^{117}In levels is given. (J.S.R.)

22138 (COO–1051–40) THE EFFECT OF CORE POLARIZATION OF THE ^{209}Bi(p,p')^{209}Bi (1.61 MeV) REACTION AT 39.5 MeV. Benenson, W.; Austin, S. M.; Locard, P. J.; Petrovich, F.; McManus, H.; Borysowicz, J. R. (Michigan State Univ., East Lansing). [2 Feb 1970]. 11p. Dep. CFSTI.

Core polarization is important in the excitation of the 1.609-MeV state of ^{209}Bi in the (p,p') reaction at 39.5 MeV. This transition involves a single proton going from the $1h_{9/2}$ to the $1i_{13/2}$ level. It is shown that most of the observed cross section is due to admixtures of the state formed by coupling the valence proton of ^{209}Bi to the highly collective 3^- state of ^{208}Pb at 2.614 MeV. The macroscopic vibrational model is used to describe the core, and the admixture found is consistent with that implied by other recent experiments. A completely microscopic calculation, in which the treatment of core polarization is based on the work of Kuo and Brown, grossly underestimates the L = 3 component of cross section. (auth)

22139 (INR–1109) LEVELS IN THE CLOSED NEUTRON SHELL NUCLIDE ^{144}Sm. Kownakci, J.; Sujkowski, Z.; Froeberg, L. E.; Ryde, H.; Adam, I. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 5p. (CONF–690804–18). Dep. CFSTI (U. S. Sales Only).

From International Conference on Properties of Nuclear States, Montreal, Canada.

Energy, angular and time distributions are measured for gamma rays deexciting states in Sm nuclei populated in (α,xn) reactions with even Nd targets. The level structure of ^{144}Sm is discussed and compared with that for other N = 82 even Z isotopes. (auth)

22140 (JINR–E–6–4782) DECAY OF ^{167}Yb. Abdurazakov, A. A.; Arlt, R.; Funke, L.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 22p. Dep. CFSTI (U. S. Sales Only).

The level scheme of the deformed nucleus ^{167}Tm was investigated in the decay of ^{167}Yb using germanium detectors and a magnetic beta spectrograph. The conversion electron spectrum, single gamma-ray spectra and prompt and delayed gamma-gamma-coincidences were measured. About 45 new transitions were observed. Most of them were introduced into a level scheme of ^{167}Tm containing 13 new levels. In the low-energy region besides the rotational bands $\frac{1}{2}^+$ [411], $\frac{7}{2}^+$ [404] and $\frac{7}{2}^-$ [523] the $\frac{5}{2}$ and $\frac{9}{2}$ members of the $\frac{1}{2}^-$ [541] band could be identified. Possibilities of interpretation of the high-lying levels are discussed based on the microscopic model. (auth)

22141 (JINR–P–6–4773) THE ^{170}Lu → ^{170}Yb DECAY. Bonch-Osmolovskaya, N.; Ballund, Kh.; Zglinskii, A.; Plochocki, A.; Preibisz, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 41p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The ^{170}Lu → ^{170}Yb decay was investigated by measuring the single gamma-spectrum and by using the coincidence technique. Based on this, the decay scheme was constructed and analyzed. The experimental results are compared with theoretical calculations. (auth)

22142 (JINR–P3–4873) ON THE KINETIC ENERGY VARIATION OF THE FRAGMENTS OF ^{235}U FISSION BY 0,15 TO 1,68 MeV NEUTRONS. Dermendzhiev, E.; Kashukeev, N.; Panteleev, Ts.; Tyan San Hak (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The variation of the kinetic energy E_k of fission fragments of ^{235}U was studied by the method of measuring the relative yield W

of fission fragments from two U targets using an electrostatic generator. The dependence $W(E_n)$ was studied in the neutron energy range E_n = 0.15 to 1.68 MeV. It was found that at $E_n \approx 0.77$ MeV and $E_n \approx 1 - 1.68$ MeV $\bar{E}_n > \bar{E}_k$ heat by ≈ 0.4 MeV. (auth)

22143 (JINR-P6-4871) STUDY OF THE PROPERTIES OF Cs NEUTRON-DEFICIENT NUCLEI. PART IV. ISOMER ^{122m_2}Cs. Neubert W.; Droste, Ch.; Chojnacki S.; Morek, T.; Levitovich, E.; Wilhelmi, Z. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Nuclear Reactions). 1969. 10p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The new isomer ^{122m_2}Cs with a half-life $T_{\frac{1}{2}} = 4.0 \pm 0.6$ min was produced in reactions ^{113}In(^{12}C,3n)^{122}Cs and ^{109}Ag(^{16}O,3n)^{122}Cs. In the β^+-decay of this isomer the levels of the quasi-rotational band in the nucleus ^{122}Xe are populated up to the 6^+ level. A possibility for the interpretation of the experimental results with the help of the existence of negative deformation is discussed. (auth)

22144 (LUNP-6903) HIGH ENERGY PHOTOFISSION IN ^{238}U, ^{232}Th, AND ^{209}Bi. Schroeder, B.; Nydahl, G.; Forkman, B. (Lund Univ. (Sweden). Dept. of Physics. Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics). Jul 1969. 29p. Dep. CFSTI (U. S. Sales Only).

The mass-yield distributions from photofission of ^{238}U and ^{232}Th at 300 to 1100 MeV and of ^{209}Bi at 700 MeV were measured using catcher-foil techniques combined with gamma-ray spectroscopy. The cross sections of symmetric and asymmetric photofission in uranium and thorium were calculated from the peak-to-valley ratios. The aim of the investigation was to improve an experimental method, combining catcher-foil techniques with gamma-ray spectroscopy, thus making it possible to measure the whole mass-yield distribution in one exposure for specific energy and target, to investigate the mass-yield distributions of uranium and thorium at 300, 500, 700, 900, and 1100 MeV and bismuth at 700 MeV, to estimate the symmetric mass distribution, to derive some information about the high-energy charge dispersion and Z_p values, and to estimate the cross sections of symmetric and asymmetric photofission in uranium and thorium. Samples of uranium, thorium, and bismuth were exposed to bremsstrahlung, and the relative fission-yields were measured by activation analysis from E_{max} = 300 to 1100 MeV. The experiment was carried out using a 1.2-GeV electron synchrotron. The samples consisted of thick layers of uranium, thorium, or bismuth powder sandwiched between 0.3-mm-thick lucite foils, one sample for irradiation consisting of twenty-five such layers. The stack was held together in a lucite container. The samples were placed in the uncollimated beam 1.5 m from the synchrotron target. Each irradiation lasted about 12 hours. (auth) (Sweden)

22145 (NP-18141) ANNUAL REPORT, 1968. Bhattacharyya, S. N.; Bhattacharyya, R. (eds.) (Saha Inst. of Nuclear Physics, Calcutta (India)). Jan 1969. 187p. Dep. CFSTI (U. S. Sales Only).

A brief résumé of the activities of the Saha Institute during the calendar year 1968 is presented. Research and development by the accelerator group, nuclear physics group, biophysics division, theoretical nuclear physics division, instrumentation division, Director's research group, and the technical physics group are summarized. An author index, list of publications in 1968, and the staff of the Institute are also listed. (W.H.K.)

22146 (ORO-2843-15) NUCLEAR CHEMISTRY GROUP PROGRESS REPORT, 1969. Muga, M. L. (Florida Univ., Gainesville). 69p. Dep. CFSTI.

The problem of distinguishing fission fragment scattering processes from ternary fission events is discussed. Alpha particle emission in the fission process was studied. Kinetic energy distributions of alpha particles and fission fragments and fragment mass distributions were measured for thermal neutron-induced fission of uranium-235. Energy loss (dE/dx) measurements of uranium-235 fission fragments as a function of mass and energy using time-of-flight techniques are presented and discussed. Also, the development of the thin-film scintillation detector for fission fragment time-of-flight measurements, for fission fragment energy loss measurements, and for other uses is described. (W.H.K.)

22147 (ORO-2972-123) RESEARCH IN NUCLEAR PHYSICS. Progress Report No. 8. (Texas Univ., Austin. Center for Nuclear Studies). Dec 1969. Contract AT(40-1)-2972. 97p. Dep. CFSTI.

Research progress at the University of Texas Center for Nuclear Studies during 1969 is reported. The work included studies on analog resonances, direct reactions, ion-atom collisions, instrumentation, and other subjects. (J.W.R.)

22148 (ORO-3924-4) ANGULAR MOMENTUM EFFECTS IN NUCLEAR REACTIONS. Progress Report, January 1–December 31, 1969. Natowitz, J. B. (Texas Agricultural and Mechanical Univ., College Station. Cyclotron Inst.). Contract AT(40-1)-3924. 59p. Dep. CFSTI.

Research performed at the Texas A and M Cyclotron Institute for the period 1 January 1969 through 31 December 1969 is described. Measurements of complete fusion cross sections in the reactions of heavy ions with Cu, Ag, Au, and Bi targets were completed. Interpreted in terms of a simple sharp cut-off model, these measurements suggest a limit to the angular momentum of compound nuclei formed in heavy ion reactions. The systematics of such reactions were used to calculate complete fusion cross sections for ^{84}Ni, ^{86}Kr and ^{136}Xe projectiles. Track detector techniques were used to measure excitation functions for the production of fission isomers in (α, xn) reactions on ^{237}Np and ^{238}U. A study of the emission of Li, Be and B fragments in the reactions of α particles with Al and Ag was initiated. A gas scintillation detector was constructed and tests are underway to determine the optimum conditions for use of this detector to study spontaneous fission isomerism. (auth)

22149 (RD/B/M-1551) DATA FOR THE CALCULATION OF GAMMA RADIATION SPECTRA FROM FISSION PRODUCTS. Davies, B. S. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 114p. (JNPC/SWP/P-160). Dep. CFSTI (U. S. Sales Only).

A complete set of available data on the properties of the fission products of ^{235}U, ^{238}U, ^{239}Pu, and ^{241}Pu is presented. The compilation covers fission yield, half-life, gamma radiation energy and intensity, and thermal neutron cross-section for fission chains of mass number 72 to 161. The gamma radiation spectrum is given as the number of photons per 100 disintegrations in each of a set of 10 keV-wide bands. (auth) (UK)

22150 (UCRL-50767) THE "HUTCH" HEAVY ELEMENT EXPERIMENT: EARLY RESULTS AND CONCLUSIONS. Eccles, S. F.; Hulet, E. K. (California Univ., Livermore. Lawrence Radiation Lab.). 24 Oct 1969. 15p. Dep. CFSTI.

A new thermonuclear device, designed to produce isotopes of the heaviest elements by exposing a uranium and thorium target to a very intense neutron flux, was exploded in July 1969. Although detailed calculations of the heavy element mass distribution have not been completed, the neutron exposure of the target was estimated at approximately 45 moles/cm^2 (equivalent 20-keV neutron flux), which is better than twice the exposure in the best previous test. Thorium contributes to the mass-yield curve only at the lowest masses, and the odd-even reversal (due to capture in an odd z-target) seen in the previous experiments is not present. Because of the increased neutron exposure, extraordinarily large amounts of known heavy isotopes were produced. The total amount of ^{257}Fm in the debris, 0.25 mg, exceeds the current reactor production of this isotope by 10^{10}. The amount of ^{250}Cm produced (possible only by this technique) was 40 mg. The search for new isotopes with mass numbers greater than 257 was unsuccessful, presumably because spontaneous fission lifetimes of these isotopes were much shorter than the time required to acquire debris samples. No activities assignable to the neutron-rich isotopes of Md, Lw, or element 104 were detected. Half-life limits for ^{259}Fm and ^{259}Md, assuming that a total of 10^{17} atoms of either was produced, are ^{259}Fm: $T_{\frac{1}{2}} \leq 0.5$ d(SF) or ≥ 250 yr (α), ^{259}Md: $T_{\frac{1}{2}} \leq 0.5$ d(SF) or $\geq 1.25 \times 10^4$ yr (α or SF). Subsidiary experiments were performed in an attempt to produce ^{46}Ar, ^{33}P, and ^{34}Si (nuclides with closed neutron shells) by multiple capture reactions in argon and phosphorus included as targets. No evidence was found for these new isotopes within the limits of the radiochemical techniques used. (auth)

22151 (UCRL-50804) ^{165}Ho, ^{151}Eu, AND NATURAL EUROPIUM CAPTURE CROSS-SECTION MEASUREMENTS. Czirr, J. B. (California Univ., Livermore. Lawrence Radiation Lab.). 12 Feb 1970. 7p. Dep. CFSTI.

Neutron time-of-flight techniques were used to measure the neutron capture cross sections for ^{165}Ho, ^{151}Eu and natural Eu in the 200-eV to 12-keV energy range, with the Livermore 33-MeV linac providing the pulsed neutron source. The detector for the de-excitation γ rays consisted of a 1-liter liquid scintillator viewed by a single photomultiplier tube. These capture-γ events were pulse-height weighted on-line to obtain a signal which is independent of variations in the γ spectrum. (auth)

22152 (WAPD-TM-814) NEUTRON CAPTURE IN ^{233}Pa. LWBR Development Program. Harris, D. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec 1969. Contract AT(11-1)-Gen-14. 34p. Dep. CFSTI.

Neutron capture in protactinium-233 affects the design of water-cooled breeder reactors both by reducing the fissile ^{235}U formed

from fertile thorium and by harming the neutron economy in the reactor. Successful prediction of the $^{233}Pa(n,\gamma)$ rate depends largely on use of adequate cross sections, and these are examined here in terms of the resonance capture integral and the $^{233}Pa(n,\gamma)$ cross section at 0.0253 eV. The transmission measurements of Simpson and Codding are analyzed to determine a resonance integral above 0.5 eV of 917 ± 63 barns, where the contribution from the range 18 to 37.5 eV is found from an area analysis carried out. The $^{233}Pa(n,\gamma)$ cross section at 0.0253 eV is determined from the transmission measurements to be 47 ± 4 barns, including the contribution from an anomalous 0.43 eV resonance. Averages of direct measurements of resonance integral and thermal cross section are smaller, 846 ± 29 barns and 40.5 ± 3.5 barns, respectively. These depend on standard data for gold and cobalt and these are reviewed. A composite of both integral and differential data implies 852 ± 26 barns and 43 ± 3 barns for resonance integral and 0.0253 eV cross section, respectively, for $^{233}Pa(n,\gamma)$ corresponding to a 7% reduction in cross sections inferred from the transmission measurements. (auth)

22153 OBSERVATION OF PARITY MIXING IN THE 501 keV GAMMA-TRANSITION IN ^{180}Hf. Jenschke, B.; Bock, P. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Phys. Lett.; 31B: 65-7(19 Jan 1970).

The 501 keV γ-radiation of ^{180}Hf was found to be circularly polarized. The experimental result for the polarization is $P = -(2.8 \pm 0.45) \times 10^{-3}$. (auth)

22154 INTERFERENCE BETWEEN NUCLEAR AND COULOMB EXCITATION OF ^{114}Cd BY ALPHA PARTICLES. Wakefield, B.; Naqib, I. M.; Harper, R. P.; Hall, I.; Christy, A. (Univ. of Liverpool). Phys. Lett.; 31B: 56-8(19 Jan 1970).

The energy dependence of the excitation probability of the first 2^+ state of ^{114}Cd was determined for α-particles in the range 8 to 18 MeV. The results were analyzed with a DWBA program which includes the Coulomb excitation process. (auth)

22155 ANGULAR DISTRIBUTION OF GAMMA RAYS FROM THE FISSION OF ^{232}Th, ^{233}U, ^{235}U, AND ^{238}U INDUCED BY 14 MeV NEUTRONS. Jeki, L.; Kluge, Gy.; Lajtai, A. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem.; 18: 13-16(1970). (In Hungarian).

The intensity of the gamma radiation following the 14-MeV neutron-induced fission of ^{232}Th, ^{233}U, and ^{238}U was measured at angles 90° and 180° relative to the flight path of fission fragments. The uncertainty in the flight direction of the fission fragments was about ±40°. The anisotropy was evaluated from the measured data as $A = I(180°)/I(90°) = 1.00 \pm 0.07$ for ^{232}Th, 1.09 ± 0.05 for ^{233}U, 1.17 ± 0.04 for ^{235}U, and 1.03 ± 0.04 for ^{238}U. (auth)

22156 STUDIES IN THE DECAY OF ^{103}Ru. Pettersson, H.; Antman, S.; Grunditz, Y. (Univ. of Uppsala). Z. Phys.; 233: 260-74(1970).

The decay of ^{103}Ru to ^{103}Rh was studied using a double-focusing spectrometer and a Ge(Li) detector. The L-conversion groups of the 40, 53, and 497 keV transitions were resolved at high resolution and unambiguous multipolarity assignments were obtained for these transitions. The level scheme proposed resembles in principle that suggested by previous investigators. One essential difference is the doublet character of the state around 0.65 MeV. Tentative spin-parity values have been assigned to all levels from the deduced multipolarities and log ft values. (auth)

22157 INTERNAL CONVERSION STUDIES OF TRANSITIONS IN ^{96}Mo. Antman, S.; Grunditz, Y.; Johansson, A.; Nyman, B.; Pettersson, H.; Svahn, B. (Univ. of Uppsala). Z. Phys.; 233: 275-92(1970).

The internal conversion spectrum from the decay of ^{96}Tc was investigated using a 50 cm radius double-focusing beta-ray spectrometer. Relevant features of the internal conversion spectrum from the decay of ^{96}Nb have also been reexamined in the same way. Special interest has been focused on investigating a proposed doublet level structure at about 2.44 MeV and higher lying levels in ^{96}Mo. Internal conversion coefficients were obtained for most transitions by combining the measured conversion electron intensities obtained in this work with recently reported gamma-ray intensities from Ge(Li) detector measurements. A level scheme has been compiled and deduced transition multipolarities were used for a discussion of spins and parities for the levels. (auth)

22158 THE 521 keV BETA TRANSITION IN ^{182}Ta DECAY. Row, K. S.; Sastry, D. L. (Andhra Univ., Waltair, India). Nuovo Cim., B; 65: 70-2(11 Jan 1970).

The beta-gamma directional correlation of the 521-67 keV cascade in ^{182}Ta decay was measured to investigate the higher-order effects. The observed correlation function at E_β = 450 keV is found to be isotropic and is given by $W_{\beta\text{-}\gamma}(\theta)$ (at E_β = 450 keV) = $1 + (0.025 \pm 0.031)P_2(\cos\theta)$. The A_{22} coefficient indicates no higher-order contributions to the 521 keV allowed but hindered beta transition of ^{182}Ta. (auth)

22159 HIGH-RESOLUTION GAMMA-RAY STUDY OF ^{185m}W. Gujrathi, S. C.; D'Auria, J. M. (Simon Fraser Univ., Burnaby, B. C.). Can. J. Phys.; 48: 502-10(1 Mar 1970).

The decay of ^{185m}W was investigated using a high-resolution Ge(Li) X-ray spectrometer and a Ge(Li)–NaI(Tl) coincidence system. The energies and relative intensities (given in parentheses) of the observed gamma rays associated with the decay of the ^{185m}W ($T_{\frac{1}{2}}$ = 1.68 min) are: 23.54 (3.3), 42.29 (1.1), 65.85_7 (100), 93.30 (0.5), 94.59 (2.2), 107.85_0 (6.8), 122.05 (1.5), 131.55_4 (84.0), 164.33_4 (11), 173.67_5 (61.5), and 187.87_9 (15.4) keV. The energy of the isomeric level was deduced to be 197.41 keV and decays to the ground state through levels at 187.88, 173.68, 93.29, 65.86, and 23.54 keV. In addition, it was deduced experimentally from measured internal-conversion coefficients that the multipolarity of the 131.55-keV transition is E3 while the 65.86-keV transition is an M1 + E2 mixture with a 30 ± 7.5% M1 component. (auth) (Canada)

22160 THE DECAY OF ^{191}Os. Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden); Baecklin, A. Ark. Fys.; 39: 411-20(Oct 1969).

Gamma-ray and conversion electron energies and intensities for transitions in ^{191}Ir was measured in the decay of ^{191}Os using a Ge(Li) detector and a double focusing beta spectrometer. The following energies (in keV) and transition multipolarities were found: 41.92 ± 0.02 (E3), 47.05 ± 0.03 (E2), 82.46 ± 0.04 (56% M1 + 44% E2) and 129.52 ± 0.03 (88% M1 + 12% E2). From a delayed coincidence measurement the half-life of the 129.52-keV level in ^{191}Ir was found to be $(1.26 \pm 0.11) \times 10^{-10}$. (auth) (SW)

22161 DECAY SCHEME OF ^{162}Gd. Chang, J. C.; Schupp, G.; Hurst, R. R. (Univ. of Missouri, Columbia). Nucl. Phys., A142: 634-40(1970).

Short-lived ^{162}Gd has been produced by double neutron capture and investigated with Ge(Li) and Si(Li) detectors. Gamma rays with energies of 402.8 and 441.6 keV were found to decay with a half-life of 8.2 ± 0.3 min. Coincidence measurements revealed a γ-ray with 38.8 keV and have led to a proposed decay scheme with levels in odd ^{162}Tb characterized by (K,I^π) at the following energies in keV: 0(1, 1^-), 38.8(1, 2^-) and 441.6(1, 1^+). The two lowest levels are interpreted as the intrinsic configuration $\frac{3}{2}^+(411)_p - \frac{5}{2}^-(523)_n$ and the highest as $\frac{7}{2}^-(523)_p - \frac{5}{2}^-(523)_n$. (auth)

22162 HIGH ANGULAR MOMENTUM STATES IN ^{110}Cd FROM THE DECAY OF 4.9h ^{110m}In. Sarantites, D. G. (Washington Univ., St. Louis). Nucl. Phys., A142: 649-72(1970).

The high angular momentum states in ^{110}Cd have been studied from the decay of 4.9 h ^{110m}In. Singles γ-ray spectra were taken with a high resolution and high efficiency Ge(Li) detector. Singles conversion electron spectra were taken with a Si(Li) detector. Extensive γγ-coincidence measurements were taken with both NaI(Tl)-Ge(Li) and Ge(Li)-Ge(Li) arrangements. From these data it was concluded that levels at 657.73, 1476.60, 1542.45, 2004.24, 2124.55, 2219.76, 2479.94, 2561.2, 3063.90, 3121.46, 3187.3, 3239.5, 3338.2, 3345.0 and 3525.1 keV in ^{110}Cd are populated in the decay of 4.9 h ^{110m}In. In addition, possible population of known levels at 2078.4, 2162.58 and 2926.58 keV in ^{110}Cd from the decay of ^{110m}In is discussed. From log ft values determined in this work, from α_K values from this work and previously published results and from γ-ray intensity information, limits have been placed for the J^π values of many levels. (auth)

22163 ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{109}Ag. Ford, J. L. C. Jr.; Robinson, R. L.; Stelson, P. H.; Tamura, Taro; Wong, Cheuk-yin (Oak Ridge National Lab., Tenn.). Nucl. Phys., A142: 525-44(1970).

The elastic and inelastic scattering of 13 MeV protons from ^{109}Ag was studied. Angular distributions were measured between the angles of 23 and 165° for particles scattered from the ground state and excited states at 0.311, 0.415, 0.702, 0.863, 0.912, 1.091, 1.26, 1.324, 1.51, 1.61, 2.15 and 2.23 MeV. The magnitudes and shapes of the angular distributions were compared with the predictions of the core-excitation model. For the states which appear to be due to coupling the odd proton to the one-phonon quadrupole and octupole states of the even core, the experimental cross sections were fitted by the DWBA approximation. Differential cross sections of the states attributed to excitation of the one- and two-quadrupole phonon states of the even core have been compared to the predictions of the coupled-channel theory with the assumption that only a $p_{\frac{1}{2}}$ proton is coupled to the core. Reasonable agreement between experiment and theory was obtained, provided an admixture of one- and two-quadrupole phonon 2^+ states was allowed. (auth)

22164 THE ^{236}U NEUTRON CAPTURE CROSS SECTION. Carlson, A. D.; Friesenhahn, S. J.; Lopez, W. M.; Fricke, M. P. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Phys.; A141: 577-94(1970).

Level parameters for unbound states in ^{237}U were obtained from capture and self-indication measurements on ^{236}U for neutron energies up to 415 eV. An estimate of the position of a bound state near the neutron binding energy was obtained from capture cross-section measurements from 0.01 to 1 eV neutron energy. Neutron strength functions were obtained from the parameters of the resolved resonances and also from average capture cross-section measurements from 0.5 to 20 keV. (auth)

22165 STUDY OF THE REACTIONS Cd(^{40}Ar,xn)Dy. Natowitz, Joseph B. (Texas A and M Univ., College Station); Alexander, John M. Phys. Rev.; 188: 1734-40(20 Dec 1969).

Excitation functions are reported for the reactions of ^{114}Cd and ^{116}Cd with ^{40}Ar to produce ^{149}Tb, ^{150}Dy, and ^{151}Dy. Range measurements in Al for the recoiling Dy products indicate that compound-nucleus formation is the first step in the reaction. From the cross sections, it is concluded that the angular momentum spectrum for the reactions Cd(^{40}Ar, 6n and 7n) is very similar to that for (^{20}Ne, 6n and 7n) reactions. The range measurements extend the span of experimental range-energy information for these nuclei from 4 to 60 MeV. These range data expressed in terms of fractional effective charge [$\gamma = Z_{eff}/Z$] are found to correlate well with data for ^{79,80}Br, ^{127}I, and fission fragments. (auth)

22166 PROMPT K X RAYS AS A FUNCTION OF FRAGMENT MASS AND TOTAL KINETIC ENERGY IN THE THERMAL FISSION OF ^{235}U. Bohn, E. M.; Wehring, B. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Phys. Rev.; 188: 1909-15(20 Dec 1969).

In order to obtain information about the deexcitation of fission fragments and the division of nuclear charge in fission for the case of thermal-neutron fission of ^{235}U, a measurement of the prompt K x rays (0 to ~1 nsec after fission) was performed. A thin foil of uranium was caused to fission by a beam of neutrons from a beam port of a nuclear reactor. The fission fragments were detected by silicon surface-barrier detectors, and the x rays, by a NaI(Tl) scintillator. A three-parameter analyzer recorded the energies of the two fragments and the energy of the x ray emitted in coincidence with the fragments. The x-ray energies were sorted "off line" according to fragment mass or total kinetic energy in order to obtain x-ray spectra for different mass groups and different energy groups. From these spectra, x-ray yields were found as a function of fragment mass and as a function of total kinetic energy of the fragments. The results are compared, where possible, with those obtained in other laboratories for the thermal-neutron fission of ^{235}U and with results for the spontaneous fission of ^{252}Cf. Differences and similarities are noted. The most probable charge versus mass was also estimated from the spectra, and these results are in agreement with radiochemical analysis. (auth)

22167 HALF-LIFE AND β SPECTRUM OF ^{176}Lu. Prodi, V.; Flynn, K. F.; Glendenin, L. E. (Argonne National Lab., Ill.). Phys. Rev.; 188: 1930-3(20 Dec 1969).

The half-life and β spectrum of ^{176}Lu were measured using liquid-scintillation-counting techniques. A half-life of $3.27 \pm 0.05 \times 10^{10}$ yr was observed. The β^- transition was found to have a maximum energy of 565 ± 25 keV. (auth)

22168 ANALOG RESONANCES OF ^{206}Tl AND ^{204}Tl. Wharton, W. R.; Courtney, W. J.; Richard, Patrick (Univ. of Washington, Seattle). Phys. Rev.; 188: 1934-41(20 Dec 1969).

The levels of ^{206}Tl and ^{204}Tl are studied by observing their analog resonances in the reactions ^{205,203}Tl(p,p_0) and ^{205,203}Tl(p,p'). The lowest-lying states formed by a proton hole ($3s_{\frac{1}{2}}$) coupled to a neutron hole ($3p_{\frac{1}{2}}$, $2f_{\frac{5}{2}}$, or $3p_{\frac{3}{2}}$) are observed to resonate weakly as in the case of the neutron-hole states formed in the ^{208}Pb(p,p_0) analog resonances. Above 2.5-MeV excitation energy in the parent nucleus, states containing neutron particles coupled to the target ground-state core are observed to resonate strongly. The energy spreads of the dominant configurations $[(3s_{\frac{1}{2}}^{-1})_p(nl_j)_n]_J$ are deduced by comparing the total widths measured in the inelastic channels to the total widths measured in the decay of the $(nl_j)_n$ configuration formed in the ^{208}Pb(p,p') reaction. The $g_{\frac{9}{2}}$ neutron strength remains highly localized in both ^{206}Tl and ^{204}Tl, which have total widths (Γ) of 219 and 217 keV, respectively, compared with the ^{209}Pb width of 253 keV. In the energy region of the $2g_{\frac{9}{2}}$-$3d_{\frac{5}{2}}$ neutron strength, Γ = 427 and 996 keV for ^{206}Tl and ^{204}Tl, respectively, compared to Γ = 300 keV for ^{209}Pb. The strengths of these configurations are thus spread over an energy range ≥ 150 keV in ^{206}Tl, ≥700 keV in ^{204}Tl, whereas the two states are split by 50 keV in ^{209}Pb. (auth)

22169 ISOTOPE SHIFT AND HYPERFINE STRUCTURE OF THE NEUTRON-DEFICIENT THALLIUM ISOTOPES. Goorvitch, David (Univ. of California, Berkeley); Davis, Sumner P.; Kleiman, Herbert. Phys. Rev.; 188: 1897-1904(20 Dec 1969).

The measurement of the isotope shift and hyperfine structure of the neutron-deficient thallium isotopes has been extended to isotopes 196m, 195, and 194m. The isotope shifts are $\Delta(196m - 205) = -288 \pm 4$ mK, $\Delta(195 - 205) = -274 \pm 4$ mK, and $\Delta(194m - 205) = -346 \pm 4$ mK in the 5350 A line. (1 mK = 10^{-3} cm^{-1}.) In the 3776 Å line, the shifts are $\Delta(196m - 205) = -288 \pm 10$ mK, $\Delta(195 - 205) = -249 \pm 4$ mK and $\Delta(194m - 205) = -348 \pm 10$ mK. The derived dipole moment of thallium-195 is $(1.55 \pm 0.04)\ \mu_N$. The shifts in the thallium sequence are compared with the shifts in the mercury sequence. (auth)

22170 NUCLEAR CHARGE DISTRIBUTION IN SYMMETRIC FISSION OF ^{235}U WITH THERMAL NEUTRONS: YIELDS OF ^{117}Ag, ^{118}Ag, AND ^{118}Pd. Weiss, H. V.; Ballou, N. E.; Elzie, J. L.; Fresco, J. M. (Naval Radiological Defense Lab., San Francisco). Phys. Rev.; 188: 1893-6(20 Dec 1969).

^{118}Pd was identified; it decays with a half-life of 3.1 ± 0.3 sec. Its cumulative fractional chain yield is 0.29 ± 0.03. The half-lives of ^{117}Ag and ^{118}Ag were verified. Their independent fractional chain yields are 0.35 ± 0.05 and 0.55 ± 0.10, respectively. The width parameter σ in the 118-mass chain is 0.65 ± 0.16, with the assumption that the distribution of nuclear charge is Gaussian. The most probable nuclear charge Z_p in the 117- and 118-mass chains is 46.22 ± 0.17 and 46.88 ± 0.12, respectively. These values of Z_p range close to those calculated for unchanged charge distribution. (auth)

22171 SPECTROSCOPY OF ^{106}Pd BY DIRECT (d,p) AND (p,α) REACTION STUDIES. Dittmer, D. L.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev.; 188: 1881-92(20 Dec 1969).

^{106}Pd was investigated by the ^{105}Pd(d,p)^{106}Pd and ^{109}Ag(p,α)^{106}Pd reactions at Van de Graaff bombarding energies of 17 and 12 MeV, respectively. Particle analysis for the stripping study employed nuclear emulsions in an Enge split-pole spectrograph and yielded 10 to 12-keV resolution for the detected protons of 21 to 24 MeV. Comparison of measured (d,p) angular distributions with nonlocal, finite-range distorted-wave Born-approximation (DWBA) calculations led to l-value assignments, J^π limits, and spectroscopic strengths for 34 transitions. The deduced values U_{lj}^2 were 0.42 for 2d states and 0.80 for the $3s_{\frac{1}{2}}$ neutron orbital and agree to within 10% with our (d,t)-derived occupancies for the same ^{105}Pd target. The low ^{109}Ag(p,α) yield at 12-MeV incident energy necessitated use of thick targets (130 μg/cm^2) and large solid angles, which led to resolutions of about 35 to 40 keV for Si counter data and 20 keV for spectrograph analysis. Angular distributions for ten (p,α) transitions were measured out to 150° and compared with local, zero-range DWBA predictions. Based on a macroscopic triton-transfer model, these calculations were particularly successful in duplicating the j dependence observed in the $p_{\frac{1}{2}}$ ground-state transition. A modified ^{106}Pd-level scheme incorporating the results with the previous literature is presented and includes 20 new states from the present studies. (auth)

22172 NEUTRON-DEFICIENT MEMBERS OF THE A = 139 DECAY CHAIN. II. 4.5-h ^{139}Pr. Berry, D. B.; Kelly, W. H.; McHarris, Wm. C. (Michigan State Univ., East Lansing). Phys. Rev.; 188: 1875-80(20 Dec 1969).

The γ rays emitted following the decay of 4.5-h ^{139}Pr were investigated with Ge(Li) and NaI(Tl) detectors in singles and anticoincidence configurations. Twelve transitions having the following energies (and relative intensities) were observed: 254.7 (53), 1320.0 (13), 1347.4 (≡100), 1375.7 (33), 1563.6 (9), 1596.6 (10), 1630.6 (70), 1653.3 (8), 1730.2 (1.6), 1818.4 (7.0), 1907.9 (3.5), and 2015.9 keV (3.0). Using energy sums and the anticoincidence results, states in ^{139}Ce at 0 ($\frac{3}{2}$+), 254.7 ($\frac{1}{2}$+), 1320.0 ($\frac{3}{2}$, $\frac{5}{2}$, $\frac{7}{2}$), 1347.4 ($\frac{1}{2}$+), 1596.6 ($\frac{3}{2}$, $\frac{5}{2}$, $\frac{7}{2}$), 1630.6 ($\frac{3}{2}$, $\frac{5}{2}$+), 1818.4 ($\frac{3}{2}$, $\frac{5}{2}$+), 1907 ($\frac{3}{2}$, $\frac{5}{2}$+), 1984.9 ($\frac{3}{2}$, $\frac{5}{2}$+), and 2015.9 keV ($\frac{3}{2}$, $\frac{5}{2}$, $\frac{7}{2}$+) were placed. The assignments were made on the basis of log ft values and relative photon intensities. The single particle versus collective behavior of the states is also discussed. (auth)

22173 NEUTRON-DEFICIENT MEMBERS OF THE A = 139 DECAY CHAIN. I. 5.5-h ^{139m}Nd AND 30-min ^{139g}Nd. Berry, D. B.; Kelly, W. H.; McHarris, Wm. C. (Michigan State Univ., East Lansing). Phys. Rev.; 188: 1851-74(20 Dec 1969).

The γ rays emitted following the decays of 5.5-h ^{139m}Nd and 30-min ^{139g}Nd were studied with Ge(Li) and NaI(Tl) detectors in singles, coincidence, and anticoincidence configurations. The study indicated 51 γ rays accompanying ^{139m}Nd decay and 21 that follow ^{139g}Nd decay. Of these, 56 were placed in decay schemes containing a total of 22 excited states. The decay scheme of $\frac{3}{2}$+ ^{139g}Nd has much in parallel with those of similar nuclei in this region, and states are populated in ^{139}Pr at 0 ($\frac{5}{2}$+), 113.8 ($\frac{7}{2}$+), 405.0 ($\frac{3}{2}$+, $\frac{1}{2}$+), 589.2 ($\frac{9}{2}$+), 916.8 ($\frac{1}{2}$+, $\frac{3}{2}$+), 1074.4 ($\frac{1}{2}$+, $\frac{3}{2}$+), 1311.8 ($\frac{1}{2}$+, $\frac{3}{2}$+, $\frac{5}{2}$+),

1328.2 ($\frac{1}{2}$+), 1405.5 ($\frac{1}{2}$+, $\frac{3}{2}$+, $\frac{5}{2}$+), 1449.5 ($\frac{1}{2}$+, $\frac{3}{2}$+, $\frac{5}{2}$+), and 1501.2 keV ($\frac{1}{2}$+, $\frac{3}{2}$+). On the other hand, 11/2− ^{139m}Nd decays only 12.7% via a 231.2-keV M4 isomeric transition and independently decays by electron capture to a set of almost completely different states in ^{139}Pr. These are at 0 ($\frac{5}{2}$+), 113.8 ($\frac{7}{2}$+), 821.9 (11/2−), 828.1 ($\frac{7}{2}$+, $\frac{9}{2}$+), 851.9 ($\frac{3}{2}$+, $\frac{7}{2}$+), 1024.0 ($\frac{7}{2}$+, $\frac{9}{2}$+, 11/2+), 1396.6 ($\frac{9}{2}$, 11/2, 13/2), 1523.2, 1624.5 ($\frac{9}{2}$−, 11/2−), 1834.1 ($\frac{9}{2}$−, 11/2−), 1927.1 ($\frac{9}{2}$−, 11/2−), 2048.8 ($\frac{9}{2}$−, 11/2−), 2174.3 ($\frac{9}{2}$−, 11/2−), and 2196.7 keV ($\frac{9}{2}$−, 11/2−). Some 80.7% of its decay goes to the last six states, and these are interpreted as being three-quasiparticle states. It appears that ^{139m}Nd is one of a few nuclides whose intrinsic structure forces the preferred mode of decay to go into a three-quasiparticle multiplet, i.e., $(\pi d_{\frac{5}{2}})^2(\nu d_{\frac{5}{2}})^{-2}(\nu h_{\frac{11}{2}})^{-1} \rightarrow (\pi d_{\frac{5}{2}})(\nu d_{\frac{5}{2}})^{-1}(\nu h_{\frac{11}{2}})^{-1}$. The three-quasiparticle states are depopulated by numerous enhanced γ transitions between states in the multiplet and fewer, apparently highly hindered, transitions to lower states. Thus, the potential exists for extracting information about states near 2 MeV in this nucleus that normally is available only for states near the ground state. (auth)

22174 ANALYSIS OF THE NEUTRON CAPTURE CROSS SECTION OF ^{238}U BETWEEN 1 keV AND 15 MeV. Davey, W. G. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Sci. Eng.; 39: 337-60(Mar 1970).

The best available values of the ^{238}U neutron capture cross section in the range of a few keV to 15 MeV are derived by evaluation of the experimental techniques and reference cross sections and, where necessary, revising and rejecting experimental values. A principal objective is to obtain ^{238}U capture cross sections which are consistent with fission cross sections previously selected by the author and which can, therefore, be used for consistent analysis of fast reactors. All available experiments are discussed and a detailed tabulation of the individual experimental data and selected best cross sections is given. (auth)

22175 DIPOLE STATES IN ^{208}Pb. Kuo, T. T. S.; Blomqvist, J.; Brown, G. E. (State Univ. of New York, Stony Brook). Phys. Lett.; 31B: 93-6(2 Feb 1970).

The dipole states in ^{208}Pb are calculated using G-matrix elements from the Hamada–Johnston potential. The large discrepancy with experiment found in previous calculations remains, even when the self-screening of the exchange term is included. Possible reasons for the discrepancy are discussed. (auth)

22176 CALCULATIONS OF NUCLEAR MATRIX ELEMENTS FOR BETA-DECAY OF RaE. Fayans, S. A.; Khodel, V. A. (Atomic Energy Inst., Moscow). Phys. Lett.; 31B: 99-102 (2 Feb 1970).

Nuclear matrix elements for β-decay of RaE are calculated on the basis of the finite Fermi systems theory. (auth)

22177 FINE STRUCTURE OF FRAGMENT YIELD AT FISSION OF HEAVY NUCLEI. Baranov, I. A.; Protopopov, A. N.; Shiryaev, B. M. Yadern. Fiz.; 10: 1149-55(1969). (In Russian).

Distributions of fragment yields in thermal neutron fission of ^{238}U were measured for various fixed kinetic energies of fragment pairs. The fine structure of the fragment yields appears only for large fixed kinetic energies of the fragment. The experimental distributions disagree with the distributions calculated using the statistical model. This disagreement may be due to uncertainties in parameters used in the calculations. (auth)

22178 DETERMINATION OF ENERGY OF THE MOST INTENSIVE α-PARTICLE GROUPS FROM ^{229}Th AND FROM SOME ISOTOPES OF Cm, Bk, AND Cf. Baranov, S. A.; Shatinskii, V. M.; Kulakov, V. M. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 10: 1110-15(1969). (In Russian).

Results of relative measurements of the energy of the most intensive α-particle groups of ^{229}Th, $^{240-244}$Cm, ^{249}Bk, and $^{249-252}$Cf, are given. In doing so the value of the energy of ^{242}Cm α_0 group whose absolute value has been recently determined by Ritz and Greenberg and found to be 6111.30 ± 0.25 keV was chosen as a standard. The α radiation energy of the isotopes was measured by means of a magnetic α spectrograph with spatial focusing of the α-particle beam at an angle $\pi\sqrt{2}$. (auth)

22179 DECAYS OF ^{113}Sb AND ^{115}Sb. Kiselev, B. G.; Burmistrov, V. R. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 10: 1105-9(1969). (In Russian).

Decays of ^{113}Sb and ^{115}Sb were investigated by means of Ge(Li) γ-spectrometers and a scintillation β-spectrometer. None of the γ lines observed before in the ^{113}Sb spectrum were confirmed except the 330-keV line. The boundary energy is found to be 2430 ± 50 keV. A decay scheme for ^{113}Sb is presented. A γ-ray line with energy 497.2 keV was observed in the ^{115}Sb spectrum. The positron boundary energy is 1500 ± 50 keV. Other γ-ray lines with energies more than 520 keV were not observed. If they are present in the ^{115}Sb decay, their intensity is no more than 0.3% per decay. (auth)

22180 COULOMB EXCITATION OF FISSION FRAGMENTS. Marshalkin, V. E.; Solov'ev, V. A.; Cherdantsev, P. A. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 149-50(1969). (In Russian).

Recent studies of excitation of light and mean nuclei by ions with energies at and above the Coulomb barrier have shown that the Coulomb excitation mechanism prevails even at energies above the Coulomb barrier. Electric quadrupole transitions are the most intense transitions during ordinary Coulomb excitation. Formulas developed for one-particle transition were used for calculating the probabilities of one-particle transitions in ^{238}U fragments during their dispersion. The estimates show that Coulomb excitation should not be neglected in studies of properties of excited fission fragments. (R.V.J.)

22181 NUCLEAR CHARGE DISTRIBUTION OF HEAVY FISSION FRAGMENTS FROM THERMAL-NEUTRON-INDUCED FISSION OF ^{235}U. Konecny, Ewald; Gunther, Helmut; Roesler, Helmut; Siegert, Guenter; Ewald, Heinz (Univ., Giessen, Ger. Technische Hochschule, Munich). Z. Phys.; 231: 59-97(1970).

Fragments from thermal-neutron induced fission of ^{235}U were separated by a mass spectrometer with respect to their masses and kinetic energies within 1 μsec. The separation principles are briefly described. For masses 130 to 139 amu the charge distributions were determined by counting the number of beta tracks emitted from the individual mass selected fission fragments in a nuclear photographic emulsion. In another method, the average number of beta particles for each fragment mass is determined by use of a 4π-proportional counter. The mean nuclear charge as a function of mass is compared with other experimental results and theoretical curves. Contradictory to the radiochemical results, this experiment yields a dip in the mean nuclear charge versus mass curve at mass 132 amu corresponding to the doubly magic nucleus (N = 82, Z = 50) ^{132}Sn. Recent theoretical calculations of Nörenberg are in agreement with this finding. (auth)

22182 RARE EARTH YIELDS IN THE INTERACTION OF 28-GeV PROTONS WITH URANIUM, BISMUTH, AND GOLD. Baechmann, Knut (Brookhaven National Lab., Upton, N. Y.). J. Inorg. Nucl. Chem.; 32: 1-15(Jan 1970).

Cross sections for the formation of a number of lanthanides by the interaction of 28-GeV protons with uranium, bismuth and gold were measured by a radiochemical method. Yield-vs.-mass curves and some information concerning the charge dispersion curves were deduced from the independent and cumulative cross sections. The yield-vs.-mass curve for uranium shows a rapid decrease with increasing mass in the region from A = 131 to A ≈ 150. The total isobaric yields appear to reach a valley or flat region at A ≈ 155. Examination of neutron deficient (N/Z ≤ 1·38) and neutron excess products (N/Z > 1·38) indicates that the observed decrease in the total yields is due primarily to a rapid decrease in yields of the neutron excess products. The charge dispersion curve for products from uranium in the rare earth region is double peaked. The valley separating the neutron excess and neutron deficient peaks is deeper in the europium region than reported previously in the cesium region. Total isobaric yields in the mass 134-155 region from bismuth and gold targets are approximately constant at ≈ 11 mb, a higher value than reported for products in the mass 72-131 region from lead targets. The charge dispersion curves for rare earth products from Bi and Au show single peaks on the neutron deficient side of stability. The results are discussed in terms of fission and spallation as possible mechanisms leading to products in the rare earth region. (auth) (UK)

22183 INTERACTIONS OF NEUTRONS WITH ^{239}Pu IN THE ENERGY RANGE BETWEEN 1,5 AND 5,5 MeV. Coppola, M.; Knitter, H.-H. (EURATOM, Geel, Belg.). Z. Phys.; 232: 286-302(1970).

Neutron scattering angular distributions of ^{239}Pu were measured at seven primary neutron energies between 1.5 and 5.5 MeV. Absolute differential scattering cross-section results are plotted and tabulated. Cross-section calculations using a central optical model were made and the results were compared with the experimental values. Moreover, nuclear temperatures of the fission and the inelastic neutron evaporation processes were extracted from the measured spectra. (auth)

22184 THE QUADRUPOLE MOMENT OF THE 2.3-MeV LEVEL IN ^{120}Sn. Wolf, H. J.; Steiner, P.; Gerdau, E.; Mueller, W. K.; Lewandowski, U.; Roggenbuck, A. (Univ., Hamburg). Z. Phys.; 232: 256-67(1970). (In German).

Time differential $\gamma\gamma$-angular correlation measurements were performed to determine the electric interaction of the 2.3-MeV

$I = 5^-$ state of ^{120}Sn in different polycrystalline antimony compounds. A calibration of the field gradient was achieved by Moessbauer experiments with the 23.8-keV $I = 3/2^+$ state in ^{119}Sn using identical sources. From the ratio of the measured electric interactions the ratio of the quadrupole moments is deduced as: [Q(2.3 MeV level, $I = 5^-$, ^{120}Sn)/Q(23.8 keV level, $I = 3/2^+$, ^{119}Sn)] = 2.86 (15). Using 0.06 (2) b for the quadrupole moment of the 23.8 keV level in ^{119}Sn one gets for the quadrupole moment of the 2.3 MeV level in ^{120}Sn Q(2.3 MeV level, $I = 5^-$, ^{120}Sn) = 0.021 (8) b. (auth)

22185 THE K-CONVERSION COEFFICIENT OF THE DECAY OF ^{191m}Os. Kirschner, Hartwig. (Univ., Goettingen, Ger.). Z. Phys.; 232: 245-55(1970). (In German).

^{191m}Os was produced by bombarding natural osmium with fast neutrons. The gamma-rays were studied with Ge(Li)-detectors. The K-conversion coefficient was determined by comparing the gamma-spectrum of ^{191m}Os with the spectrum emitted by the osmium anode of an X-ray tube. The result is $\alpha_K = 38.4$. This result is compared with theory. (auth)

22186 KINETIC ENERGY OF FRAGMENTS IN THE FISSION OF ^{235}U BY NEUTRONS WITH ENERGIES FROM 0 TO 0.6 MeV. Dyachenko, P. OP. (Inst. of Physics and Power Engineering, Obninsk, USSR); Kuzminov, B. D.; Lajtai, A. Phys. Lett.; 31B: 122-3(2 Feb 1970).

The data on the kinetic energy and mass fragment distributions in the 0 to 0.6 MeV energy neutron induced fission of ^{235}U are analyzed. It is shown that in terms of the energy balance no variation of charge distribution between individual fragments occurs in this range of bombarding neutron energies. (auth)

22187 DISINTEGRATION BY SPONTANEOUS FISSION OF VERY SHORT HALF LIFE NUCLEI OBTAINED BY REACTIONS OF ^{14}N ON ^{169}Tm. Peter, J. (IPN, Orsay, France). Phys. Lett.; 31B: 124-5(2 Feb 1970). (In French).

In the bombardment of ^{169}Tm by ^{14}N, fission was observed to occur from nuclei with a half-life of 3.0 ± 0.5 ns. The formation cross section is about 1 μb. (auth)

22188 MEASUREMENTS OF ^{90}Zr, ^{96}Zr, $^{98}Mo(p,p'e)$THROUGH ISOBARIC ANALOG RESONANCES. Courtney, W. J.; Moore, C. F. (Univ. of Texas, Austin). Phys. Lett.; 31B: 131-4 (2 Feb 1970).

Internal conversion electrons from 0_2^+ to 0_1^+ electric monopole transitions are easily identified in the charged particle spectra resulting from proton bombardment. Excitation functions are presented for these electron groups at proton energies corresponding to analog resonances in the proton plus target system. (auth)

22189 NEW ISOTOPES ^{23}F, ^{24}F, ^{25}Ne, AND ^{26}Ne, PRODUCED IN NUCLEAR REACTIONS WITH HEAVY IONS. Artukh, A. G.; Avdeichikov, V. V.; Gridnev, G. F.; Mikheev, V. L.; Volkov, V. V.; Wilczynski, J. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 31B: 129-30(2 Feb 1970).

New isotopes: ^{23}F, ^{24}F, ^{25}Ne and ^{26}Ne were obtained by bombardment of a ^{232}Th target with 174-MeV ^{22}Ne ions. The reaction products were identified with a magnetic spectrometer combined with the dE/dx, E technique. (auth)

22190 ISOMER SHIFT IN THE 82 keV TRANSITION OF ^{154}Sm. Wheeler, R. M.; Atzmony, U.; Hardy, K. A.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Phys. Lett.; 31B: 206-8(16 Feb 1970).

An isomer shift of -0.15 ± 0.09 mm/s was observed for the 82 keV transition in ^{154}Sm between Sm^{3+} and Sm^{2+} compounds. A value of $\Delta\langle r^2\rangle/\langle r^2\rangle = 0.46 \pm 0.34 \times 10^{-5}$ is deduced and compared with measured and theoretically predicted values of $\Delta\langle r^2\rangle/\langle r^2\rangle$ in ^{152}Sm and ^{154}Sm. (auth)

22191 NON-ADIABATIC CALCULATION OF POSITIVE PARITY STATES IN ^{161}Er AND ^{163}Er. Baznat, M. I.; Chernei, M. I.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 31B: 192-4(16 Feb 1970).

A calculation of positive parity states in ^{161}Er and ^{163}Er, within the non-adiabatic rotational model, has been performed, taking the Coriolis coupling of seven Saxon–Woods potential orbitals into account. Two parameters, the rotational parameter $\hbar^2/2\phi$ and the effective pairing force strength G_{eff} were used in the calculation. It is shown that a satisfactory fit of the calculation to the experimental energy levels with spin values up to $29/2$ can be achieved only if a strongly reduced pairing force and rotational parameter values close to those for neighboring even nuclei are used. (auth)

Nuclear Theory

Refer also to abstracts 21012, 21993, 22093, 22100, and 22113.

22192 (BNL-tr-311) DOUBLE-HUMPED FISSION BARRIER AND NEUTRON-INDUCED NUCLEAR FISSION. Gai, E. V.; Ignatyuk, A. V.; Rabotnov, N. S.; Smirenkin, G. N. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz; 10: 542-8(1969). 17p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 8939.

22193 (JINR-P4-4833) ON THE OPTICAL POTENTIAL FOR HIGH-ENERGY ELECTRON SCATTERING. Petkov, I. Zh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 8p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The amplitude of the elastic scattering of electrons by nuclei is considered taking into account the effective monopole nuclear excitation. In a high-energy approximation a formula for a corresponding optical potential is deduced, which is a complicated even function of atomic number. (auth)

22194 (LA-4327) PERTURBATION TRANSFORMATION OF NUCLEAR CROSS-SECTION PARAMETERS BETWEEN WIGNER-EISENBUD AND KAPUR-PEIERLS FORMALISMS: THE PERTA PROGRAM. Harris, Donald R. (Los Alamos Scientific Lab., N. Mex.). 25 Nov 1969. Contract W-7405-eng-36. 16p. Dep. CFSTI.

The transformation between nuclear cross sections in the Wigner-Eisenbud and Kapur-Peierls formalisms is expressed by treating off-diagonal elements of the inverse level matrix as perturbations. A FORTRAN IV program, PERTA, is developed to compute the perturbation transformation. The applicability of the perturbation to real nuclei is tested for low-energy neutron cross sections of fissile nuclides. The perturbation transformation is applied to the study of properties of Kapur-Peierls parameters, namely, their probability distribution, the range in energy of interference effects, and the degree of asymmetry of resonant shapes of radiative capture cross sections. (auth)

22195 (LUNP-6906) QUALITATIVE MODEL OF HIGH-ENERGY PHOTOFISSION IN HEAVY ELEMENTS. Schroeder, Bent; Forkman, Bengt (Lund Univ. (Sweden). Dept. of Physics). Oct 1969. 17p. Dep. CFSTI (U. S. Sales Only).

A qualitative model has been worked out to describe the de-excitation of heavy nuclei after absorption of photons. Pion effects and fission parameters have been studied. The resemblance with proton-induced fission failed to explain the great amount of asymmetric fission in the photon case. Heavy nuclei, however, were expected to de-excite independently of the way in which the excitation was achieved. Another unexplained observation was that the resonances in the fission cross sections occurred about 75 MeV higher than the resonances in the cross sections for photoproduction of pions on free nucleons. These observations became the basis of derivations of a qualitative model to investigate the de-excitation scheme of high-energy photofission. (auth) (Sweden)

22196 (UCRL-19514) T = 0 AND T = 1 PAIRING IN LIGHT NUCLEI. Goodman, Alan L. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1969. Contract W-7405-eng-48. 333p. Dep. CFSTI.

Thesis.

A generalized quasiparticle transformation is presented which includes n-n, p-p, and n-p (T = 0 and T = 1) pairing correlations. The quasiparticle co-ordinates are required to be complex. The resulting gap equations for N = Z even-even nuclei are solved for the nuclei in the sd shell. To permit interaction between the Hartree-Fock (HF) and pair potentials, the Hartree-Fock-Bogolyubov (HFB) equations, including both T = 0 and T = 1 pairing, are also solved for these nuclei. Although T = 1 pairing correlations are not significant, T = 0 pairing correlations play a very important role, rectifying many of the failures of the HF theory in this region. T = 0 pairing restores axial symmetry to the equilibrium shapes of ^{24}Mg and ^{32}S and explains the vibrational nature of ^{36}Ar. These conclusions are reproduced by the following nucleon-nucleon interactions: the Yale t-matrix (s-p-sd), the Nestor-Davies-Krieger-Baranger effective interaction (s-p-sd and s-p-sd-pf), and the Rosenfeld effective interaction (sd). Evaluation of various approximations to HFB is facilitated by deriving the canonical form of the density matrix and the pairing tensor for generalized isospin pairing. The canonical basis often bears no resemblance to the corresponding HF basis. The HFB equations are derived by a variational principle. The self-consistent sym-

metries of the HFB solutions are discussed. Usage of the same effective interaction in both the HF and the pair potential is justified. (auth)

22197 (UCRL-Trans-1399) MULTIPARTICLE STATES. Peker, L. K. Translated for Univ. of California, Lawrence Radiation Lab., Berkeley, from pp 163-209 of 4th Winter Seminar on the Theory of the Nucleus and the Physics of High Energies, Leningrad, USSR, February 5-17, 1969. 41p. (CONF-690217-2). Dep. CFSTI.

A survey on the three- and four-particle states of nuclei is presented. The use of information on multiparticle structure in studying residual interactions is described. (J.W.R.)

22198 PRODUCTION OF PIONS IN PERIPHERAL NUCLEUS-NUCLEUS SCATTERING. Westroem, M. (Univ., Marburg, Ger.). Z. Phys.; 233: 195-208(1970). (In German).

The production of pions by nucleus-nucleus scattering under particular kinematical conditions is discussed. Taking into account only electromagnetic interactions between the nuclei a simple formalism is presented which allows to express the differential cross section and the angular distribution of the produced pions in terms of so called generalized form factors. Using the concept of impulse approximation these form factors can be explicitly calculated. (auth)

22199 THE THEORY OF INTERNAL CONVERSION AT THE M-SHELL. Barysagiebski, L. A.; Trusau, V. F. (Inst. of Physics, Minsk). Vestsi Akad. Nauk BSSR, Ser. Fiz.-Mat. Navuk, No. 3, 114-19(1968). (In Belorussian).

Tables of the fundamental radial integrals of the internal conversion at the M shell in the case of M1, M2, E1, and E2 atomic transitions are presented. Radial electron functions obtained by the integration of the differential Dirac equations were used to calculate the integrals, taking into account the finite dimensions of the nucleus and the shielding effect of the basis of the derivations of D. R. and W. Hartree. The study represents a further development of the compilations published by M. E. Rose and K. Siegbahn. (TTT)

22200 TWO-PARTICLE RESONANCE NARROWING IN THREE-PARTICLE NUCLEAR REACTIONS. Komarov, V. V.; Salman, H. A. (Moscow State Univ.). Phys. Lett.; 31B: 52-5(19 Jan 1970).

Narrowing of the two α-particle resonance width in the final state of the reaction leading to three α-particles in the exit channel is considered on the base of general multiparticle scattering theory. Calculations were made for interpretation of the narrowing effect in the reaction $^{11}B(p,3\alpha)$ and $^{10}B(d,3\alpha)$. Some rules are presented for identification of the many-particle reaction mechanism by the final state interaction resonance width. Use of such reactions to deduce the spectroscopic properties of highly excited intermediate states is discussed. (auth)

22201 SECOND-ORDER CORRLCTION TO THE Λ BINDING ENERGY IN NUCLEAR MATTER. Ram, B.; Williams, W. (New Mexico State Univ., Las Cruces). Phys. Lett.; 31B: 49-51(19 Jan 1970).

The second-order correction to the Λ binding energy in nuclear matter evaluated in the independent pair approximation is found to be small. (auth)

22202 HERMITIAN RANDOM MATRICES WITH SMALL IMAGINARY PART. Mehta, M. L. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nuovo Cim., B; 65: 107-16 (11 Jan 1970). (In French).

Perturbation theory is applied to the study of Hermitian random matrices whose imaginary part is very small compared to the real part. The distribution of spacings of the eigenvalues is considerably altered for small spacings, while for larger spacings the situation is the same as if the imaginary part were zero. (auth)

22203 NEGATIVE μ-MESON INTERNAL CONVERSION FROM ^{239}Pu RADIATIONLESS FISSION FRAGMENTS. Grama, N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 14: 701-2 (1969).

Nuclear fission may occur due to excitation following the 2p-1s radiationless transition in mesic atoms. In such a process the meson does not disappear but is captured by one of the fragments. The meson may then be reemitted by the internal conversion process. The μ^- internal conversion coefficient for ^{239}Pu was calculated to test these possibilities. (J.W.R.)

22204 TOWARDS A NEW THEORY OF ALPHA DECAY. Dumitrescu, Ovidiu (Bucharest Univ.); Sandulescu, Aurel. Rev. Roum. Phys.; 14: 667-72(1969).

An expression for the alpha decay constant, which independent of the channel radius, is described. Using this expression the perturbation potential causing the decay has a nonzero magnitude for sufficiently large distances. The difficulties of the new formula are connected with the choosing of the optical parameters and solving the system of coupled equations. (J.W.R.)

22205 THE CONSTRUCTION OF NEUTRON CROSS SECTIONS IN THE UNRESOLVED RESONANCE REGION. Ishiguro, Yukio; Katsuragi, Satoru; Nakagawa, Masayuki; Takano, Hideki (Japan Atomic Energy Research Inst., Ibaraki). Nucl. Sci. Eng.; 40: 25-37(Apr 1970).

A new method has been proposed for the selection of a single resonance structure or ladder used for the calculation of the cross sections in the unresolved resonance region. This method is especially useful for fissile nuclides, where level spacings are quite narrow, and is capable of taking the rather complicated energy-variation of alpha values into consideration. By use of the present method, studies have been made of the cross sections of ^{235}U, ^{238}U, ^{239}Pu, and ^{240}Pu. For the construction of the cross sections of these nuclides, new evaluations have also been made of the average resonance parameters, which were used in generation of the ladders. The calculated results are shown to be a very good representation of the low-resolution experimental data. (auth)

22206 EVALUATION OF ALLOWED β-DECAY. Wilkinson, D. H. (Nuclear Physics Lab., Oxford. Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.; A143: 365-72(1970).

Approximations are presented that permit the quite accurate evaluation of the f-function using only elementary means. For negaton emission the approximations cover all Z-values; for positon emission only the lighter elements are covered. (auth)

22207 ON FINITE-RANGE EFFECTS IN TWO-NUCLEON TRANSFER REACTIONS. Joseph, J.; Fayard, C.; El-Baz, E.; Lafoucriere, J. (Univ., Lyon). Nucl. Phys.; A142: 217-24 (1970).

A finite range effect on a two-nucleon transfer reaction like (p,t) was studied and compared with the zero-range and Bencze-Zimanyi methods. It appears that this effect is quite important in the evaluation of the spectroscopic factors. (auth)

22208 EVALUATION OF THE IMAGINARY PART OF THE OPTICAL POTENTIAL WITH A MONTE-CARLO METHOD. Afnan, I. R. (Univ. of California, Davis); Tang, Y. C. Nucl. Phys.; A141: 653-63(1970).

A study of the use of a Monte-Carlo method in evaluating multidimensional integrals, where the domain of integration is restricted by the Pauli exclusion principle, is made. This method is applied to the evaluation of the imaginary part of the optical potential using the Fermi-gas model and experimental nucleon-nucleon cross sections. The results show that the discrepancy reported by Greenlees et al. between the calculated and phenomenological imaginary potentials is not due to the assumption of an isotropic angular distribution in the nucleon-nucleon differential cross sections. (auth)

22209 ELASTIC AND INELASTIC NUCLEON SCATTERING. Rompala, John Thaddeus. Clemson, S. C.; Clemson Univ. (1969). 61p.

Thesis.

The scattering of a projectile nucleon from a target system of N nucleons is investigated. Two aspects of this many-body problem are of primary interest. The first is consideration of the fact that the total scattering system is made up of like fermions and that the wave function describing this system must be antisymmetric with respect to exchange of any two coordinate labels. The second aspect is the use of a nonorthogonal complete set in the spectral representation of the Green-function operator. The in-state of the system is first written using the notation of second quantization. A transition is then made to the in-state wave function. Thus a properly antisymmetrized in-state wave function is obtained. A spectral representation of the Green-function operator is then formulated. This is achieved using a single particle model hamiltonian together with the complete ortho-normal set of its eigenfunctions. In order to preserve the antisymmetric properties of the in-state wave function these eigenfunctions are then antisymmetrized. The resulting set is, however, non-orthogonal. A formal elimination of a subset of this non-orthogonal set allows the construction of a spectral representation which refers to elastic and inelastic channels only. As a result the T matrix for scattering into a given channel is expressed in terms of a projectile distorted wave state and the given target state. This matrix also permits a straight forward perturbation expansion in terms of a residual interaction and demonstrates explicitly exchange effects. (auth)

22210 NUCLEAR ELASTIC SCATTERING PROGRAM WITH PARAMETER SEARCH. Smith, William R. (Trinity Univ., San Antonio). Comput. Phys. Commun.; 1: 198-206(Jan 1970).

The program ELASTIC optimizes the parameters of a nuclear optical model potential including spin–orbit coupling, and this program also calculates the angular distribution of the corresponding elastic scattering cross section. (J.F.P.)

22211 INTERMEDIATE (d,p) APPROXIMATION. Peaslee, D. C. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 56: 259-67(Jan 1970).

A general formulation of (d,p) stripping without many-body considerations is used to compare the DWBA and "sudden" approximations. They appear somewhat complementary, and the importance is remarked of using a complete set of wave functions in the sudden approximation. A completeness procedure different from the one commonly used leads to an intermediate approximation having points of tangency with all other approximations; essentially a Born approximation with Watson-type corrections. This should be sufficiently accurate to yield spectroscopic factors of correct magnitude. (auth)

22212 UNIFIED THEORY OF NUCLEAR ROTATIONS. Villars, Felix M. H.; Cooper, G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 56: 224-58(Jan 1970).

The nuclear Hamiltonian is expressed in terms of the total angular momentum variables, and of intrinsic particle coordinates by means of a contact transformation. The intrinsic structure is approximated by a Hartree–Fock solution, and the Coriolis coupling diagonalized by admitting particle-hole excitations. It is shown that in this approximation, the rotational energy takes the conventional form, as given by the "unified" model, the moment of inertia being determined by a self-consistent "cranking" formula. This, and corresponding results for matrix elements of multipole operators, substantiate the validity of the more intuitive procedures based on the unified model and on the use of single-particle orbitals in deformed potential wells. (auth)

22213 OPTICAL-MODEL POTENTIAL AND BROAD SINGLE-PARTICLE RESONANCES. Cugnon, J. (Univ., Liege). Z. Phys.; 233: 133-45(1970).

The dynamical energy dependence of the optical-model potential is studied in the case of a broad single-particle resonance. It is found that the optical-model potential is slowly energy-varying. The optical phase shift and the transmission coefficient are shown to display a resonance. (auth)

22214 EMPIRICAL NORMALIZATION OF THE (t,p) REACTION. Flynn, E. R.; Hansen, O. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett.; 31B: 135-7(2 Feb 1970).

An empirical normalization of a DWBA (t,p) reaction code is shown to be consistent to better than a factor of two when applied to data from Ca to Pb at bombarding energies of 12 MeV and 20 MeV. (auth)

22215 NUCLEAR CHEW-FRAUTSCHI TRAJECTORY FOR NUCLIDES WITH Z = 1 to 20. Iwao, Syurei (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 42: 1304-18(Dec 1969).

A study of the "nuclear Chew-Frautschi trajectory" for low-energy nuclear physics in the Z = 1 to 20 region is examined in the light of the current nuclear model. Seven examples for nucleon-nucleus and deuteron-nucleus scattering are discussed as an illustration. It is too early to draw conclusions on the definite form of the nuclear trajectory by empirics. Since the R-matrix theory of nuclear reactions is independent of the nuclear model, one can infer that the Reggeized S-matrix theory, and hence the nuclear Chew-Frautschi trajectory, may be defined without referring to the specific nuclear model by showing the equivalence of two approaches. (auth)

22216 ENERGY-INDEPENDENT EFFECTIVE INTERACTIONS IN SHELL-MODEL CALCULATIONS. Schneider, H. G. (Technische Univ., Hanover). Z. Phys.; 232: 239-44(1970).

It is shown, that the use of an energy-independent effective interaction in a shell model calculation implies a strongly energy dependent residual interaction and thus a nucleon-nucleon interaction which is strongly energy dependent in the energy region of interest. (auth)

22217 PROBLEM OF STABILITY OF SUPERHEAVY NUCLEI. Weyer, Wolfgang (Univ., Cologne). Z. Phys.; 232: 231-8(1970).

Finite nuclei are calculated in the statistical model of Thomas and Fermi. The density distribution of the particles is assumed as spherical and approximated by Fermi II. The description of the potential energy is based on known many-body theories of the nuclear matter and the neutron gas using non-local forces. A numerical fit is made to the realistic nuclei and the calculations of the binding energy and density are extrapolated to superheavy systems. No stability is found if the nucleon number exceeds 300. (auth)

22218 THREE-BODY CONTRIBUTIONS TO THE GROUND-STATE ENERGY OF NUCLEAR MATTER. Ristig, Manfred (Univ., Cologne). Z. Phys.; 232: 279-85(1970).

The theory of nuclear matter is investigated by means of the method of unitary transformations in the special case of point transformations. The induced three body forces are constructed, their contributions to the ground state energy of nuclear matter are given in first order perturbation theory, and the connection with Jastrow's procedure is shown. A first numerical estimate of the three body contributions to the energy per particle gives approximately 1 MeV in the physical density range. For higher values of the Fermi momentum ($k_F \approx 2$ fm^{-1}) the contributions increase rapidly. Generally the induced three body forces cannot be neglected if one wants to calculate the correct saturation data. (auth)

22219 GENERALIZATION OF THE INDEPENDENT PAIR MODEL TO DEGENERATE NUCLEAR STATES. Gutsch, Uwe (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 232: 268-78(1970).

The equations of the Independent Pair Model for finite nuclei are generalized to nuclear states non-describable by a single shell model configuration. As an application of these generalized equations to excited states, the energy of the excited T = 0, $J^\pi = 0^+$-state of ^{4}He was calculated by an approximate solution. Using a spin-averaged square well potential with hard core and Serber exchange character, with all parameters being determined from two-nucleon data, the calculation yields an excitation energy of 21.58 MeV compared to the experimental value of about 20.1 MeV. (auth)

22220 PROBLEM OF THE AVERAGE NUCLEAR FIELD AND ONE-PARTICLE NUCLEAR LEVELS. Grabowski, Janusz (Inst. of Nuclear Physics, Krakow); Kalinkin, Boris N. Nukleonika; 14: 571-606(1969). (In Russian).

The results of the calculations of the one-particle nuclear levels in the Saxons-Wood shape nuclear potential for spherical and axially deformed nuclei are presented. Analysis of these results and comparison of the spectroscopic calculations done with this model and the earlier ones (e.g., the Nilsson model) show that calculations with the diffuse edge potential are in much better agreement with the experimental data. (auth)

22221 THE REDUCED WIDTHS OF NUCLEON CLUSTERS IN THE UNITARY SYMMETRY SCHEME. Sabalyauskas, L.; Petrauskas, A. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 303-9(1969). (In Russian).

The formula for calculating reduced widths of nucleon clusters for the nonnormal parity states in the unitary symmetry scheme is presented. The reduced widths for the nuclei ^{5}He, ^{5}Li, ^{6}He and ^{6}Li are calculated and compared with the experimental data. (auth)

22222 ON THE APPLICATION OF THE HARTREE-FOCK-BOGOLYUBOV EQUATIONS TO A MICROSCOPIC THEORY OF NUCLEAR ROTATIONS. Ring, P.; Beck, R.; Mang, H. J. (Technische Hochschule, Munich). Z. Phys.; 231: 10-25(1970).

The Hartree-Fock-Bogolyubov-Equations of the cranking model are used to give a description of nuclear rotations in a general single particle model. Numerical results for some rare earth nuclei are presented. (auth)

22223 POLARIZAREA SI ORIENTAREA IN FIZICA NUCLEARA. VOLUMUL I. BAZELE CURANTICE ALE POLARIZARII DE SPIN. (Polarization and Orientation in Nuclear Physics. Volume I. Quantum Mechanical Bases of Spin Polarization). Manzatu, Ion. Bucuresti; Editura Academiei Republicii Socialiste Romania (1969). 372p.

Essentially, every nuclear reaction is a quantum collision process but in spite of the vast amount of experimental data, there is still no general theory concerning the collision of quantized objects. The book attempts to establish a quantum-mathematical framework for nuclear collision processes, devoting the first volume to the treatment of spin polarization phenomena. The Hilbert space is explained on the basis of the kinetic moment of the quantum theory, reviewing the concepts of eigenvectors and eigenvalues of operators, the coupling of kinetic moments, Clebsch-Gordan coefficients, and related notions. The Schroedinger equation is examined in order to study collisions between spin-free particles, considering also the integral equation for collisions and

the Green function. The implication of spin on the function of state and polarization is explained, considering target materials with spin, collision and polarization cross sections, and the density matrix. A chapter is devoted to the polarization of particles in nuclear reactions. (TTT)

22224 SYMMETRY-CONSERVING HARTREE–FOCK–BOGOLYUBOV THEORY AND ITS APPLICATION TO COLLECTIVE NUCLEAR ROTATION. Beck, R.; Mang, H. J.; Ring, P. (Technische Hochschule, Munich). Z. Phys.; 231: 26-47(1970).

The HFB-Theory is combined with the projection method in order to account for the rotational symmetry of the Hamiltonian. It is shown that the cranking model provides a special solution of the "projected" HFB-Equations which result from a minimization of the projected energy. (auth)

22225 CAN NUCLEAR PROCESSES BE STIMULATED BY ELECTRONIC STRUCTURE OF MACROMOLECULES. Konarski, J.; Wszolek, B.; Kukiel, E. (Technical Univ., Poznan, Poland). Acta Phys. Pol.; 36: 1111-13(Dec 1969).

An influence of electronic structure of macromolecules on the nuclear states is discussed. (auth)

22226 STATISTICAL ESTIMATE OF THE BREATHING MODE ENERGY. Brueckner, K. A. (Univ. of California, La Jolla); Giannoni, M. J.; Lombard, R. J. Phys. Lett.; 31B: 97-8(2 Feb 1970).

Monopole vibrations of spherical nuclei, the so-called breathing modes, are described in terms of harmonic oscillations of the nuclear radius. The energy density formalism is used to estimate the excitation energy of the one phonon state. (auth)

22227 NEW CLASSIFICATION FOR THE j^n CONFIGURATION. Elliott, J. P.; Evans, J. A. (Univ. of Sussex, Brighton, Eng.) Phys. Lett.; 31B: 157-9(16 Feb 1970).

A factorization of the j^n shell leads to a simple classification scheme and to the possibility of a much simpler method for calculating matrix elements. (auth)

22228 ON THE EFFECT OF THE P_6 DEGREE OF FREEDOM IN THE NUCLEAR POTENTIAL AT EQUILIBRIUM AND FISSION DISTORTIONS. Moeller, P.; Nilsson, B. (Lund Inst. of Tech., Sweden). Phys. Lett.; 31B: 171-4(16 Feb 1970).

The inclusion of a P_6 term in the nuclear potential yields some improvement of fission barriers in the actinide region and increases the tendency of the nucleus to develop a waistline at large distortions. (auth)

22229 ON THE DEPENDENCE OF QQ-FORCE STRENGTH ON DEFORMATION. Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 31B: 175-6(16 Feb 1970).

The QQ-force for RPA calculations with Nilsson's single potential is studied and its dependence on nuclear deformation is estimated. (auth)

22230 DEPENDENCE OF OFF-ENERGY-SHELL BRUECKNER REACTION MATRIX ELEMENTS FOR FINITE NUCLEI ON THE SHAPE OF THE REPULSIVE CORE. MacKellar, A. D. (Univ. of Kentucky, Lexington); Becker, R. L. Phys. Lett.; 31B: 177-80(16 Feb 1970).

Off-energy-shell Brueckner reaction matrix elements for finite nuclei, which are required in any three or four body cluster calculation, are obtained for realistic hard- and soft-core interactions. Significant differences are found between the two interactions. (auth)

22231 EFFECT OF CORE POLARIZATION ON ANALOGUE TO ANTI-ANALOGUE M1 TRANSITION PROBABILITIES. Marippuu, S. (Univ., Utrecht). Phys. Lett.; 31B: 181-3(16 Feb 1970).

A reduction of the analog to anti-analog M1 transition strength in odd-A nuclei is obtained from core polarization. The reduction is especially large if both the odd particle and the particles contributing to the core polarization have $j = l + \frac{1}{2}$. The distribution of the anti-analog strength in ^{45}Sc was calculated with two different nuclear interactions. A large reduction of the analog to anti-analog M1 transition strength, in agreement with experiment is found. (auth)

22232 INTERMEDIATE STATE TRANSITION RATES IN THE GRIFFIN MODEL. Williams, F. C. Jr. (Univ. of Rochester, N. Y.). Phys. Lett.; 31B: 184-6(16 Feb 1970).

Restrictions on transitions among the intermediate particle-hole states due to the two body nature of the residual interaction are examined. The precompound emission probability is derived using the transition rates developed and the properties of the result are discussed. (auth)

22233 DETERMINATION OF THE PAIRING STRENGTH FROM THE CONDITION FOR THE TOTAL ENERGY MINIMUM. Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 31B: 187-8(16 Feb 1970).

The use of the condition $\langle r^2 \rangle_{BCS} = \text{const}$ is proposed to determine the pairing force strength by minimization of the total energy of the nucleus. (auth)

22234 AN EFFECTIVE $\sigma \times p$ FORCE IN NUCLEAR MATTER. Cohen, B. L. (Univ. of Pittsburgh). Phys. Lett.; 31B: 195-7 (16 Feb 1970).

It is shown that the nucleon–nucleon spin-orbit interaction leads to an effective force on a nucleon passing through nuclear matter in the direction $\sigma \times p$. This force causes nucleons to move in a circular orbit of nuclear dimensions. For the Hamada–Johnston potential, the orbit radius is about 5 fm. (auth)

22235 NON-ADIABATIC CORRECTIONS TO THE DECOUPLING PARAMETER FOR THE $\frac{1}{2}^-[541]$ ROTATIONAL BAND. Hjorth, S. A.; Ryde, H. (Research Inst. for Physics, Stockholm. Univ. of Stockholm). Phys. Lett.; 31B: 201-2(16 Feb 1970).

Decoupling parameters much larger than expected from the classical Nilsson model have recently been determined from observed parts of the $\frac{1}{2}^-[541]$ rotational band. These large values are seen to be a consequence of the Coriolis force. (auth)

22236 THE CORRECTION OF NUCLEAR CROSS SECTIONS USING CORRELATED BEAMS. Slobodrian, R. J. (Univ., Laval, Quebec). Nucl. Instrum. Methods; 79: 141-3(1970).

A method is described for the correction of cross sections, based upon the detection of an associated particle correlated through nuclear interactions with the particle of interest. (auth)

22237 HAUSER–FESHBACH NUCLEAR SCATTERING SUBROUTINE LIANA. Smith, William R. (Trinity Univ., San Antonio). Comput. Phys. Commun.; 1: 181-90(Jan 1970).

A computer program is described which computes the scattering angular distribution and integrated cross section for any two-body nuclear reaction which proceeds through a statistical distribution of compound nucleus states. This program is the subroutine LIANA. (J.F.P.)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 20953 and 22386.

22238 (CEA-R-3932) USE OF BORON AS A BURNABLE POISON IN THE EL 4 MODERATOR DURING STARTUP TESTS. Cherot, Jean; Girard, Yves (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1970. 60p. (In French). Dep. CFSTI (U. S. Sales Only).

The properties of Li, Cd, Gd and B used as burnable poisons in the moderator of a heavy water reactor were compared. Boric acid was chosen for measuring reactivity balance in EL 4. It was used to compensate the reactivity excess of the first load in EL 4 start-up tests, and to measure xenon effects and to follow the fuel evolution in power tests. The techniques used are described and the difficulties encountered in the determination of the involved concentrations are mentioned. 10 references. (France)

22239 (STI/PUB-21/37) HEAVY-WATER REACTORS. Bibliographical Series No. 37. (International Atomic Energy Agency, Vienna (Austria)). 1970. 545p. IAEA $14.00.

The bibliography contains 2515 references to work published up to 1968, an Introduction, an Author Index, and a Subject Index. The references are arranged according to the heavy water reactors of particular countries. The Introduction gives a brief survey of the development of heavy water reactors and includes lists of research, test, and experimental heavy water reactors in operation, nuclear power plants with heavy water reactors in operation and nuclear power plants with heavy water reactors under construction. (auth)

22240 NUCLEAR POWER: AN ENVIRONMENTAL ASSET. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Environ. Sci. Technol.; 4: 269(Apr 1970).

The need for nuclear power in helping to provide the future electric generating requirements is discussed. Efforts must be increased to improve public understanding of the nature of our energy sources, our energy requirements, and our need for long-range planning on utilization of energy sources. (H.D.R.)

22241 POSSIBILITIES OF AUTOMATION IN THE CONTROL OF NUCLEAR POWER STATION. Costantin, Peter; Parthier, Siegbert; Schuster, Werner (AEG-Telefunken, Frankfurt am Main). At. Strom.; 16: 3-5(Jan 1970). (In German).

The aims of, and the requirements for, automation systems in nuclear power stations are listed. The degree of automation achieved at the moment is characterized by the construction of the central main switching station with the electronic functional group controls connected in series, as well as the use of process computers for on-line data processing. The possible designs for increasing the degree of automation are discussed. (auth)

22242 ACTIVITIES OF THE MINISTER OF INDUSTRY IN THE TRADING AND MANUFACTURING OF MATERIALS FOR NUCLEAR POWER PLANTS. Gaglio, Elio. pp 173-83 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22243 RINGHALS NUCLEAR POWER STATION. Molin, Aake (Aktiebolaget ASEA-ATOM, Vasteras, Sweden). ASEA (Allm. Sv. Elek. A. B.) J.; 42: 143-7(1969).

A brief description of the Ringhals Nuclear Power Station is given with special reference to the unit size, site, station layout and ASEA-ATOM deliveries. (auth) (Sweden)

22244 THE FIRST FUEL CHARGE FOR OSKARSHAMN NUCLEAR POWER-STATION. Brandberg, Sven; Widell, Bjoern (Aktiebolaget ASEA-ATOM, Vasteras, Sweden). ASEA (Allm. Sv. Elek. A. B.) J.; 42: 154-9(1969).

The first fuel charge for the reactor for Unit 1 of Oskarshamn Nuclear Power Station, located at Simpevarp, Sweden, is described. (auth) (Sweden)

22245 THE REACTOR FOR UNIT ONE IN RINGHALS. Sundqvist, Cnut (Aktiebolaget ASEA-ATOM, Vasteras, Sweden). ASEA (Allm. Sv. Elek. A. B.) J.; 42: 148-53(1969).

A description of the reactor for the first unit in Ringhals Nuclear Power Station is given. Particular attention is paid to the basic layout, design of the reactor core, control equipment and auxiliary systems. (auth) (Sweden)

22246 PHYSICS DESIGN OF THE FERMI MIXED OXIDE CORE. Klickman, A. E.; Wehmeyer, D. B. (Atomic Power Development Associates, Inc., Detroit). pp 299-302 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

The analysis of critical experiments is related to the uncertainties in predicting the operating parameters of an oxide core for the Fermi Reactor. Preliminary investigation of potential accident situations indicates the reactor to be safe within the range of parameter uncertainties. (auth) (UK)

22247 PHYSICS MEASUREMENTS IN THE FERMI REACTOR. Batch, M. L.; Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit). pp 336-45 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Tests on the Enrico Fermi Atomic Power Plant fast reactor, completed up to 100 MW(t), have established that the power distribution, shutdown reliability, and dynamic characteristics of the reactor are safely within design limits. An extensive testing program was carried out at low powers (less than 1 MW(t)). Material worths were measured by substituting special subassemblies; neutron fluxes were mapped by both foils and counters; control and safety rods were calibrated and evaluated by period, swapping, sub-critical multiplication, and rod-drop techniques; and reactivity transfer function was measured by oscillator-rod and control-rod-jog techniques. Comparisons of the results of the low power program with predictions show: fluxes, power, and material worths were accurately predicted by multi-group calculations throughout the core but were underestimated in the outer blanket; safety rod worth and temperature coefficient were overestimated; and the reactivity transfer function very nearly matched the function derived from delayed neutron parameters only. In general, it was found that predictions based upon the critical experiment data were inaccurate, because of the differences between the critical experiment configuration and the actual core configuration. Measurements performed at power levels above 1 MW(t) included power coefficient, reactivity transfer functions, and noise analysis. The measured power coefficient was lower than predicted (which is consistent with the errors in the other predictions). The reactivity transfer functions showed the system to be very stable in both manual and automatic control modes. Correlation functions from noise analysis showed very long lag times between reactor outlet and upper plenum outlet temperatures, indicative of a non-mixing, non-channeling Na flow in the upper plenum. (auth) (UK)

22248 ASPECTS OF D.F.R. REACTOR PHYSICS. Edwards, A. G.; Tait, D.; Crowe, D. S. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 348-53 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

A selection of topics is discussed which have arisen in the operation of D.F.R. since it returned to power following the leak repair. These include flux distributions, reactivity surveillance and performance of the delayed neutron monitors. Where appropriate, reference is made to the equivalent P.F.R. problem. (auth) (UK)

Operation and Economics

22249 (ACNP-69503) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 21, March 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 21 May 1969. Contract AT(11-1)-850. 27p. (DOCKET-1155-22). Dep. CFSTI.

22250 (ACNP-69504) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 22, April 1969.

(Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 18 Jun 1969. Contract AT(11-1)-850. 39p. (DOCKET-1155-23). Dep. CFSTI.

22251 (ACNP-69505) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 23, May 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-850. 35p. (DOCKET-1155-24). Dep. CFSTI.

22252 (ACNP-69506) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 24, June 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 4 Aug 1969. Contract AT(11-1)-850. 13p. (DOCKET-1155-25). Dep. CFSTI.

22253 (AECL-3558) STATUS OF HEAVY WATER MODERATED REACTORS. Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb 1970. 15p. Dep. CFSTI (U. S. Sales Only). AECL $0.50.

Research and development programs and construction schedules for heavy water moderated power reactors are reviewed. Operation performances for heavy water moderated power reactors are compared. (D.C.C.)

22254 (COO-651-40) ELK RIVER REACTOR. Monthly Operating Report No. 51, January 1967. (Rural Cooperative Power Association, Elk River, Minn.). 28 Feb 1967. Contract AT(11-1)-651. 28p. (DOCKET-1151-5). Dep. CFSTI.

22255 (COO-651-42) ELK RIVER REACTOR. Monthly Operating Report No. 52, February 1967. (Rural Cooperative Power Association, Elk River, Minn.). 3 Apr 1967. Contract AT(11-1)-651. 20p. (DOCKET-1151-6). Dep. CFSTI.

22256 (COO-651-43) ELK RIVER REACTOR. Monthly Operating Report No. 53, March 1967. (Rural Cooperative Power Association, Elk River, Minn.). 28 Apr 1967. Contract AT(11-1)-651. 25p. (DOCKET-1151-7). Dep. CFSTI.

22257 (COO-651-44) ELK RIVER REACTOR. Monthly Operating Report No. 54, April 1967. (Rural Cooperative Power Association, Elk River, Minn.). 7 Jun 1967. 21p. (DOCKET-1151-8). Dep. CFSTI.

22258 (COO-651-45) ELK RIVER REACTOR. Monthly Operating Report No. 55, May 1967. (Rural Cooperative Power Association, Elk River, Minn.). 21 Jul 1967. 51p. (DOCKET-1151-9). Dep. CFSTI.

22259 (COO-651-46) ELK RIVER REACTOR. Monthly Operating Report No. 56, June 1967. (Rural Cooperative Power Association, Elk River, Minn.). 14 Aug 1967. 36p. (DOCKET-1151-10). Dep. CFSTI.

22260 (COO-651-47) ELK RIVER REACTOR. Monthly Operating Report No. 57, July 1967. (Rural Cooperative Power Association, Elk River, Minn.). 24 Aug 1967. 22p. (DOCKET-1151-11). Dep. CFSTI.

22261 (COO-651-50) ELK RIVER REACTOR. Monthly Operating Report No. 58, August 1967. (Rural Cooperative Power Association, Elk River, Minn.). 27 Sep 1967. 30p. (DOCKET-1151-12). Dep. CFSTI.

22262 (COO-651-52) ELK RIVER REACTOR. Monthly Operating Report No. 60, October 1967. (Rural Cooperative Power Association, Elk River, Minn.). 15 Dec 1967. 27p. (DOCKET-1151-13). Dep. CFSTI.

22263 (COO-651-53) ELK RIVER REACTOR. Monthly Operating Report No. 61, November 1967. (Rural Cooperative Power Association, Elk River, Minn.). 4 Jan 1968. Contract AT(11-1)-651. 25p. (DOCKET-1151-14). Dep. CFSTI.

22264 (COO-651-54) ELK RIVER REACTOR. Monthly Operating Report No. 62, December 1967. (Rural Cooperative Power Association, Elk River, Minn.). 31 Jan 1968. 24p. (DOCKET-1151-15). Dep. CFSTI.

22265 (COO-651-55) ELK RIVER REACTOR. Monthly Operating Report No. 63, January 1968. (Rural Cooperative Power Association, Elk River, Minn.). 26 Feb 1968. 28p. (DOCKET-1151-16). Dep. CFSTI.

22266 (COO-651-58) ELK RIVER REACTOR. Monthly Operating Report No. 65, March 1968. (Rural Cooperative Power Association, Elk River, Minn.). 30 Apr 1968. 47p. (DOCKET-1151-17). Dep. CFSTI.

22267 (COO-651-59) ELK RIVER REACTOR. Monthly Operating Report No. 66, April 1968. (Rural Cooperative Power Association, Elk River, Minn.). 28 May 1968. 20p. (DOCKET-1151-18). Dep. CFSTI.

22268 (COO-651-60) ELK RIVER REACTOR. Monthly Operating Report No. 67, May 1968. (Rural Cooperative Power Association, Elk River, Minn.). 24 Jun 1968. 68p. (DOCKET-1151-19). Dep. CFSTI.

22269 (COO-651-61) ELK RIVER REACTOR. Monthly Operating Report No. 68, June 1968. (Rural Cooperative Power Association, Elk River, Minn.). 5 Aug 1968. 18p. (DOCKET-1151-20). Dep. CFSTI.

22270 (COO-651-63) ELK RIVER REACTOR. Monthly Operating Report No. 69, July 1968. (Rural Cooperative Power Association, Elk River, Minn.). 29 Aug 1968. 40p. (DOCKET-1151-21). Dep. CFSTI.

22271 (COO-651-66) ELK RIVER REACTOR. Monthly Operating Report No. 71, September 1968. (Rural Cooperative Power Association, Elk River, Minn.). 18 Oct 1968. 22p. (DOCKET-1151-22). Dep. CFSTI.

22272 (COO-651-67) ELK RIVER REACTOR. Monthly Operating Report No. 72, October 1968. (Rural Cooperative Power Association, Elk River, Minn.). 26 Nov 1968. 28p. (DOCKET-1151-23). Dep. CFSTI.

22273 (COO-651-68) ELK RIVER REACTOR. Monthly Operating Report No. 73, November 1968. (Rural Cooperative Power Association, Elk River, Minn.). 7 Jan 1969. 24p. (DOCKET-1151-24). Dep. CFSTI.

22274 (COO-651-69) ELK RIVER REACTOR. Monthly Operating Report No. 74, December 1968. (Rural Cooperative Power Association, Elk River, Minn.). 21 Jan 1969. 25p. (DOCKET-1151-25). Dep. CFSTI.

22275 (COO-651-70) ELK RIVER REACTOR. Monthly Operating Report No. 75, January 1969. (Rural Cooperative Power Association, Elk River, Minn.). 24 Feb 1969. 24p. (DOCKET-1151-26). Dep. CFSTI.

22276 (COO-651-71) ELK RIVER REACTOR. Monthly Operating Report No. 76, February 1969. (Rural Cooperative Power Association, Elk River, Minn.). 21 Mar 1969. 25p. (DOCKET-1151-27). Dep. CFSTI.

22277 (COO-651-73) ELK RIVER REACTOR. Monthly Operating Report No. 77, March 1969. (Rural Cooperative Power Association, Elk River, Minn.). 23 Apr 1969. 17p. (DOCKET-1151-28). Dep. CFSTI.

22278 (COO-651-74) ELK RIVER REACTOR. Monthly Operating Report No. 78, April 1969. (Rural Cooperative Power Association, Elk River, Minn.). 21 May 1969. 19p. (DOCKET-1151-29). Dep. CFSTI.

22279 (COO-651-75) ELK RIVER REACTOR. Monthly Operating Report No. 79, May 1969. (Rural Cooperative Power Association, Elk River, Minn.). 24 Jun 1969. 15p. (DOCKET-1151-30). Dep. CFSTI.

22280 (DLCS-5000469) QUARTERLY OPERATING REPORT [OF SHIPPINGPORT ATOMIC POWER STATION], FOURTH QUARTER, 1969. (Duquesne Light Co., Shippingport, Pa. Power Stations Dept.). Contract AT(11-1)-292. 22p. Dep. CFSTI.

Operations and maintenance requirements during October to December 1969 are described. Coolant water chemistry measurements are presented. Test programs are reviewed. (D.C.C.)

22281 (DOCKET-50029-113) YANKEE NUCLEAR POWER STATION. Operation Report No. 110, February 1970. (Yankee Atomic Electric Co., Westboro, Mass.). 20 Mar 1970. 6p. Dep. CFSTI.

22282 (DOCKET-50171-44) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 22, December 1967. (Philadelphia Electric Co., Pa.). 30 Jan 1968. 14p. Dep. CFSTI.

22283 (DOCKET-50206-44) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Operation Report, August 1969. (Southern California Edison Co., Los Angeles). Sep 1969. Contract AT(30-1)-3270. 7p. (NYO-3270-29). Dep. CFSTI.

22284 (DOCKET-50206-45) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Operation Report, September

1969. (Southern California Edison Co., Los Angeles). Oct 1969. Contract AT(30-1)-3270. 6p. (NYO-3270-30). Dep. CFSTI.

22285 (DOCKET-50206-46) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Operation Report, October 1969. (Southern California Edison Co., Los Angeles). Nov 1969. Contract AT(30-1)-3270. 8p. (NYO-3270-31). Dep. CFSTI.

22286 (DOCKET-50206-47) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Operation Report, November 1969. (Southern California Edison Co., Los Angeles). Dec 1969. Contract AT(30-1)-3270. 6p. (NYO-3270-32). Dep. CFSTI.

22287 (DOCKET-50206-48) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Operation Report, December 1969. (Southern California Edison Co., Los Angeles). Jan 1970. Contract AT(30-1)-3270. 6p. (NYO-3270-33). Dep. CFSTI.

22288 (DOCKET-50206-49) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Operation Report, January 1970. (Southern California Edison Co., Los Angeles). Feb 1970. Contract AT(30-1)-3270. 5p. (NYO-3270-34). Dep. CFSTI.

22289 (DOCKET-50206-50) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Operation Report, February 1970. (Southern California Edison Co., Los Angeles). Mar 1970. Contract AT(30-1)-3270. 8p. (NYO-3270-35). Dep. CFSTI.

22290 (DOCKET-50213-34) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. Operation Report No. 70-2, February 1970. (Connecticut Yankee Atomic Power Co., Haddam). 24 Mar 1970. Contract AT(30-1)-3250. 12p. (NYO-3250-45). Dep. CFSTI.

22291 (DOCKET-50219-65) OYSTER CREEK NUCLEAR GENERATING STATION, UNIT NO. 1. Provisional Operating License No. DPR-16. Semiannual Report No. 1, May 3-December 31, 1969. (Jersey Central Power and Light Co., Morristown, N. J.). 2 Apr 1970. 20p. Dep. CFSTI.

22292 (TID-23301) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 2, April 1966. (Philadelphia Electric Co., Pa.). 16 Aug 1966. Contract AT(40-1)-2586. 22p. (DOCKET-50171-27). Dep. CFSTI.

22293 (TID-23851) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 54, March 1967. (Consumers Power Co., Jackson, Mich.). 15 Apr 1967. Contract AT(11-1)-932. 22p. (DOCKET-50155-29). Dep. CFSTI.

22294 (TID-23972) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 55, April 1967. (Consumers Power Co., Jackson, Mich.). 15 May 1967. Contract AT(11-1)-932. 17p. (DOCKET-50155-30). Dep. CFSTI.

22295 (TID-24048) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 18, August 1967. (Philadelphia Electric Co., Pa.). 18p. (DOCKET-50171-28). Dep. CFSTI.

22296 (TID-24183) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 58, July 1967. (Consumers Power Co., Jackson, Mich.). 15 Aug 1967. 18p. (DOCKET-50155-31). Dep. CFSTI.

22297 (TID-24184) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 59, August 1967. (Consumers Power Co., Jackson, Mich.). 15 Sep 1967. 15p. (DOCKET-50155-32). Dep. CFSTI.

22298 (TID-24185) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 60, September 1967. (Consumers Power Co., Jackson, Mich.). 15 Oct 1967. 19p. (DOCKET-50155-33). Dep. CFSTI.

22299 (TID-24204) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 21, November 1967. (Philadelphia Electric Co., Pa.). 28 Dec 1967. 17p. (DOCKET-50171-29). Dep. CFSTI.

22300 (TID-24206) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 61, October 1967. (Consumers Power Co., Jackson, Mich.). 15 Nov 1967. 16p. (DOCKET-50155-34). Dep. CFSTI.

22301 (TID-24271) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 62, November 1967. (Consumers Power Co., Jackson, Mich.). 15 Dec 1967. 15p. (DOCKET-50155-35). Dep. CFSTI.

22302 (TID-24274) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 23, January 1968. (Philadelphia Electric Co., Pa.). 29 Feb 1968. 25p. (DOCKET-50171-30). Dep. CFSTI.

22303 (TID-24307) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 63, December 1967. (Consumers Power Co., Jackson, Mich.). 15 Jan 1968. 17p. (DOCKET-50155-36). Dep. CFSTI.

22304 (TID-24335) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 24, February 1968. (Philadelphia Electric Co., Pa.). 28 Mar 1968. 30p. (DOCKET-50171-31). Dep. CFSTI.

22305 (TID-24350) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 64, January 1968. (Consumers Power Co., Jackson, Mich.). 15 Feb 1968. 17p. (DOCKET-50155-37). Dep. CFSTI.

22306 (TID-24351) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 65, February 1968. (Consumers Power Co., Jackson, Mich.). 15 Mar 1968. 20p. (DOCKET-50155-38). Dep. CFSTI.

22307 (TID-24376) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 25, March 1968. (Philadelphia Electric Co., Pa.). 30 Apr 1968. 30p. (DOCKET-50171-32). Dep. CFSTI.

22308 (TID-24490) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 26, April 1968. (Philadelphia Electric Co., Pa.). 29 May 1968. 21p. (DOCKET-50171-33). Dep. CFSTI.

22309 (TID-24492) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 66, March 1968. (Consumers Power Co., Jackson, Mich.). 15 Apr 1968. 16p. (DOCKET-50155-39). Dep. CFSTI.

22310 (TID-24525) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 27, May 1968. (Philadelphia Electric Co., Pa.). 28 Jun 1968. 24p. (DOCKET-50171-34). Dep. CFSTI.

22311 (TID-24576) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 28, June 1968. (Philadelphia Electric Co., Pa.). 30 Jul 1968. 17p. (DOCKET-50171-35). Dep. CFSTI.

22312 (TID-24634) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 29, July 1968. (Philadelphia Electric Co., Pa.). 28 Aug 1968. 14p. (DOCKET-50171-36). Dep. CFSTI.

22313 (TID-24691) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 30, August 1968. (Philadelphia Electric Co., Pa.). 27 Sep 1968. 17p. (DOCKET-50171-37). Dep. CFSTI.

22314 (TID-24749) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 31, September 1968. (Philadelphia Electric Co., Pa.). 14p. (DOCKET-50171-38). Dep. CFSTI.

22315 (TID-24792) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 32, October 1968. (Philadelphia Electric Co., Pa.). 12p. (DOCKET-50171-39). Dep. CFSTI.

22316 (TID-24864) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 33, November 1968. (Philadelphia Electric Co., Pa.). 6 Jan 1969. 19p. (DOCKET-50171-40). Dep. CFSTI.

22317 (TID-24920) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 34, December 1968. (Philadelphia Electric Co., Pa.). 7 Feb 1969. 12p. (DOCKET-50171-41). Dep. CFSTI.

22318 (TID-24997) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 68, May 1968. (Consumers Power Co., Jackson, Mich.). 15 Jun 1968. 16p. (DOCKET-50155-40). Dep. CFSTI.

22319 (TID-24998) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 71, August-October 1968. (Consumers Power Co., Jackson, Mich.). 17p. (DOCKET-50155-42). Dep. CFSTI.

22320 (TID-24999) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 72, November 1968–January 1969. (Consumers Power Co., Jackson, Mich.). 18p. (DOCKET-50155-43). Dep. CFSTI.

22321 (TID-25005) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 36, February 1969. (Philadelphia Electric Co., Pa.). 8 Apr 1969. 17p. (DOCKET-50171-42). Dep. CFSTI.

22322 (TID-25144) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Monthly Operations Report No. 37, March 1969. (Philadelphia Electric Co., Pa.). 12 May 1969. 14p. (DOCKET-50171-43). Dep. CFSTI.

22323 (WAPD-MRP-130) PRESSURIZED WATER REACTOR PROJECT. Technical Progress Report, July 26, 1969–October 24, 1969. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT-11-1-GEN-14. 24p. Dep. CFSTI.

The first Core 2, Seed 2, 150 MW(e) demonstration test in the Shippingport reactor was successfully performed. Initial Core 2 operations with Seed 2 have resulted in an indicated total flow decrease of about 2%, but recent measurements indicate that the flow appears to have stabilized. As expected the reactivity loss rate inferred from measurements indicates a slightly positive value at about 120 EFPH, but by 300 EFPH had reversed to a slightly negative reactivity loss rate. A primary to secondary tube leak was detected in the "D" steam generator. (auth)

22324 OUTLINE OF FUEL MELTING INCIDENT AND SUBSEQUENT WORK ON THE ENRICO FERMI REACTOR. Tashimo, Masanori. Nippon Genshiryoku Gakkaishi; 12: 135-44(1970). (In Japanese).

On October 5, 1966, during a slow increase in power, the Enrico Fermi Reactor was shut down in an orderly manner after it was observed that the control rods were withdrawn further than normal for 31 MW(t), that several subassemblies had abnormally high outlet temperatures, and that a small amount of fission products was detected. Subsequently various investigations and analyses were performed to analyze this incident. It was established as a result that fuel melting had occurred in two fuel subassemblies, M-098 and M-127. Inspection of the lower plenum and study of the analytical model indicated that one of the two Zr segments originally installed on the conical flow guide had become loose and had partially blocked the inlet nozzles of four subassemblies adjacent to each other. To prevent recurrence of similar trouble the remaining Zr segments on the conical flow guide were removed, and a malfunction detection analyzer was installed in the instrumentation and safety system. Preoperational tests are now under way, with the Enrico Fermi Atomic Power Plant scheduled to be restored to full power operation in February 1970. The fuel melting incident and the subsequent repairs and modifications performed on the reactor are described. (auth)

Safety and Siting

Refer also to abstract 22440.

22325 (DOCKET-1155-21) LA CROSSE BOILING WATER REACTOR. Addendum to Amendment No. 3 of Provisional Operating Authorization DPRA-6 [for Dairyland Power Cooperative, La Crosse, Wis.]. (Dairyland Power Cooperative, La Crosse, Wis.). 17 Mar 1970. 3p. Dep. CFSTI.

Additional monitoring locations for the containment structure leak detection system are described. Calibration and response levels for the detectors are presented. (D.C.C.)

22326 (DOCKET-1155-26) LA CROSSE BOILING WATER REACTOR. Amendment 3 to Application for Transfer of Provisional Operation Authorization DPRA-5 [for Allis-Chalmers Mfg. Co., Bethesda, Md.]. (Dairyland Power Cooperative, La Crosse, Wis.). 16 Apr 1968. 6p. Dep. CFSTI.

The containment structure leak detection system is described. Response levels for the detectors are calculated. (D.C.C.)

22327 (DOCKET-50003-33) INDIAN POINT STATION, UNIT NO. 1. Operator Retraining Program. (Consolidated Edison Co. of New York, Inc., New York). 19 Mar 1970. 4p. Dep. CFSTI.

22328 (DOCKET-50003-34) INDIAN POINT STATION, UNIT NO. 1. License No. DPR-5. Technical Specifications Change. (Consolidated Edison Co. of New York, Inc., New York). 1 Apr 1970. 5p. Dep. CFSTI.

Modifications in the fuel loading pattern of Region 1 through Region 5 of Core B are described. (D.C.C.)

22329 (DOCKET-50003-35) INDIAN POINT STATION, UNITS 1, 2, AND 3. Facility Design Changes, October 1, 1969–March 31, 1970. (Consolidated Edison Co. of New York, Inc., N. Y.). 1 Apr 1970. 2p. (DOCKET-50247-33; DOCKET-50286-27). Dep. CFSTI.

Frequency monitors were installed on each of the 120 VAC special load boards to monitor the frequency of the motor generator sets which supply power to these boards. In order to eliminate reactor trips which have occurred as a result of malfunctions in the one input dropped section of the average flux computer, the computer circuitry was modified to eliminate automatic restoration of a channel to the averaging circuit. Screens were installed over the condenser cooling water inlet bays. The condenser cooling water discharge canal was connected to a common canal for all three reactor units. Two new house service boilers for Unit No. 2 were placed into service. (D.C.C.)

22330 (DOCKET-50010-65) DRESDEN NUCLEAR POWER STATION, UNITS 1 AND 2. Operator Retraining Program. (Commonwealth Edison Co., Chicago, Ill.). 10 Apr 1970. 3p. (DOCKET-50237-39). Dep. CFSTI.

22331 (DOCKET-50029-114) YANKEE NUCLEAR POWER STATION. Operator Retraining Program. (Yankee Atomic Electric Co., Westboro, Mass.). 10 Apr 1970. 5p. Dep. CFSTI.

22332 (DOCKET-50133-29) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Addendum A to Technical Specifications Proposed Change No. 29. (Pacific Gas and Electric Co., San Francisco, Calif.). 30 Mar 1970. 7p. Dep. CFSTI.

Mechanical, nuclear, and thermal hydraulic characteristics of the Jersey Nuclear Company fuel assemblies are reviewed. The operation schedule for the fuel assemblies is described. (D.C.C.)

22333 (DOCKET-50146-50) SAXTON REACTOR. License No. DPR-4. Technical Specifications Change Request No. 35. (Saxton Nuclear Experimental Corp., Pa.). 24 Mar 1970. 2p. Dep. CFSTI.

Modifications in Zircaloy 4-clad UO_2 fuel rods are described. (D.C.C.)

22334 (DOCKET-50146-51) SAXTON REACTOR. License No. DPR-4. Technical Specifications Change Request No. 37. (Saxton Nuclear Experimental Corp., Pa.). 23 Mar 1970. 2p. Dep. CFSTI.

Modifications in Zircaloy 4-clad UO_2 fuel rods are described. (D.C.C.)

22335 (DOCKET-50146-52) SAXTON REACTOR. License No. DPR-4: Technical Specifications Change No. 38. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Apr 1970. 2p. Dep. CFSTI.

For Saxton Nuclear Experimental Corp., Pa.

Modifications in the fission product monitor in the primary coolant system are described. The locations of 1 mR/hr to 30 R/hr GM tubes are analyzed. (D.C.C.)

22336 (DOCKET-50155-44) [BIG ROCK POINT NUCLEAR PLANT]. License No. DPR-6: Technical Specifications Change No. 20. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Mar 1970. 2p. Dep. CFSTI.

For Consumers Power Co., Jackson, Mich.

The use of 1 – Y bus for the normal supply of power to the control rod drive position indicating system and associated interlocks and relays is described. (D.C.C.)

22337 (DOCKET-50155-45) BIG ROCK POINT NUCLEAR PLANT. Operator Retraining Program. (Consumers Power Co., Jackson, Mich.). 10 Apr 1970. 17p. Dep. CFSTI.

22338 (DOCKET-50171-45) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. License No. DPR-12: Technical Specifications Change No. 9. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Mar 1970. 3p. Dep. CFSTI.

For Philadelphia Electric Co., Pa.

Fuel element specifications for Core 2 are presented. Loading requirements for standard and test fuel elements and low power testing are described. (D.C.C.)

22339 (DOCKET-50183-22) ESADA VALLECITOS EXPERIMENTAL SUPERHEAT REACTOR (EVESR). [Preliminary Safety Analysis Report], Modification No. 1 to Amendment 16. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). 9 Mar 1970. 12p. Dep. CFSTI.

Handling and utilization restrictions for nuclear materials are described. (D.C.C.)

22340 (DOCKET-50206-51) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Predicted Boron Concentration. (Southern California Edison Co., Los Angeles). 3 Apr 1970. 5p. Dep. CFSTI.

22341 (DOCKET-50219-64) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Main Steam Line Isolation Valve Testing. (Jersey Central Power and Light Co., Morristown, N. J.). 20 Mar 1970. 11p. Dep. CFSTI.

22342 (DOCKET-50219-66) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Scram Pressure Switch Leak. (Jersey Central Power and Light Co., Morristown, N. J.). 3 Apr 1970. 2p. Dep. CFSTI.

22343 (DOCKET-50244-41) ROBERT E. GINNA NUCLEAR POWER STATION, UNIT 1. Operator Retraining Program Description. (Rochester Gas and Electric Corp., N. Y.). 10 Apr 1970. 6p. Dep. CFSTI.

22344 (DOCKET-50247-32) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 16 (Includes Final Facility Description and Safety Analysis Report, Suppl. 7). (Consolidated Edison Co. of New York, Inc., New York). 30 Mar 1970. 232p. Dep. CFSTI.

Design requirements for the containment spray and air filtration systems and safety injection system are described. Stress analysis for cooling system components are presented. Containment structure design parameters are illustrated. Activation sequences of protection systems are tested for accident conditions. (D.C.C.)

22345 (DOCKET-50261-26) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. Seismic Analysis of Class I Equipment and Piping. (Carolina Power and Light Co., Raleigh, N. C.). 6 Apr 1970. 4p. Dep. CFSTI.

22346 (DOCKET-50271-18) VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT. Proposed Technical Specifications and Bases. (Vermont Yankee Nuclear Power Corp., Rutland). 31 Mar 1970. 106p. Dep. CFSTI.

22347 (DOCKET-50271-19) VERMONT YANKEE NUCLEAR POWER STATION. [Preliminary Safety Analysis Report], Amendment 11. (Vermont Yankee Nuclear Power Corp., Rutland). 9 Mar 1970. 36p. Dep. CFSTI.

Design parameters are listed. Refueling operations are described. Engineered safeguards are discussed. Accident conditions are analyzed. The quality assurance program is described. (D.C.C.)

22348 (DOCKET-50285-23) FORT CALHOUN REACTOR. Pre-Operational Environmental Survey. Fifth Report, 4th Quarter 1969. (Trapelo/West, Richmond, Calif.). 23 Feb 1970. 16p Dep. CFSTI.

For Omaha Public Power District, Nebr.

22349 (DOCKET-50295-10) ZION STATION, UNITS 1 AND 2. Construction Codes of Practice Applicable to the Concrete Work. (Commonwealth Edison Co., Chicago, Ill.). 1 Apr 1970. 5p. (DOCKET-50304-10). Dep. CFSTI.

22350 (DOCKET-50317-17) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Salt Water Cooling. (Baltimore Gas and Electric Co., Md.). 31 Mar 1970. 145p. (DOCKET-50318-17). Dep. CFSTI.

22351 (DOCKET-50327-17) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 24 Mar 1970. 91p. (DOCKET-50328-17). Dep. CFSTI.

For Tennessee Valley Authority, Office of Power, Chattanooga.

22352 (DOCKET-50329-11) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 9. (Consumers Power Co., Jackson, Mich.). 30 Mar 1970. 24p. (DOCKET-50330-11). Dep. CFSTI.

Flood hazards for the reactor site are analyzed. Control room shielding requirements are calculated. Soil requirements for the reactor site are described. (D.C.C.)

22353 (DOCKET-50334-20) BEAVER VALLEY POWER STATION. Preliminary Safety Analysis Report, Amendment 6. (Duquesne Light Co., Pittsburgh, Pa.). 18 Sep 1969. 13p. Dep. CFSTI.

Design requirements for interlock system to prevent cold slug accidents from main coolant loop isolation are described. Start-up procedures for an inactive coolant loop are presented. (D.C.C.)

22354 (DOCKET-50334-21) BEAVER VALLEY POWER STATION, [UNIT NO. 1]. Preliminary Safety Analysis Report, Amendment 15. (Duquesne Light Co., Pittsburgh, Pa.). 30 Mar 1970. 41p. Dep. CFSTI.

Seismic stress analysis for Class 1 structures and systems is presented. (D.C.C.)

22355 (DOCKET-50336-10) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 6. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 10 Apr 1970. 233p. Dep. CFSTI.

Piping systems are described and classified. Performance requirements of the containment system filters and containment structure coatings are analyzed. Soil restrictions for buildings and structures are presented. Atmosphere releases from the reactor site are described. Emergency core cooling systems and auxiliary power systems are discussed. Thermal and hydraulic requirements for the core are analyzed. Complete technical specifications are included. (D.C.C.)

22356 (DOCKET-50358-1) WM. H. ZIMMER NUCLEAR POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 1. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 6 Apr 1970. 594p. (DOCKET-50359-1). Dep. CFSTI.

Information on William H. Zimmer Power Reactor Units 1 and 2 is presented under the following broad topics: Introduction and Summary; Site; and Reactor. (D.C.C.)

22357 (DOCKET-50358-2) WM. H. ZIMMER NUCLEAR POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 2. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 6 Apr 1970. 264p. (DOCKET-50359-2). Dep. CFSTI.

Information on William H. Zimmer Power Reactor Units 1 and 2 is presented under the following broad topics: Reactor Coolant System; Containment; and Core Standby Cooling System. (D.C.C.)

22358 (DOCKET-50358-3) WM. H. ZIMMER NUCLEAR POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 3. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 6 Apr 1970. 363p. (DOCKET-50359-3). Dep. CFSTI.

Information on William H. Zimmer Power Reactor Units 1 and 2 is presented under the broad topic: Control and Instrumentation. (D.C.C.)

22359 (DOCKET-50358-4) WM. H. ZIMMER NUCLEAR POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 4. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 6 Apr 1970. 366p. (DOCKET-50359-4). Dep. CFSTI.

Information on William H. Zimmer Power Reactor Units 1 and 2 is presented under the following broad topics: Electrical Power Systems; Radioactive Waste Systems; Auxiliary Systems; Steam and Power Conversion System; Station Structures and Shielding; Conduct of Operations; and Plant Safety Analysis. (D.C.C.)

22360 (DOCKET-50358-5) WM. H. ZIMMER NUCLEAR POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 5. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 6 Apr 1970. 330p. (DOCKET-50359-5). Dep. CFSTI.

Appendices presented contain information on: Pressure Boundary Integrity Criteria; Outline of Proposed Technical Specifications; Equipment Design Criteria; Quality Control System; Station Atmospheric Release Limit Calculations; Conformance to AEC General Criteria; and Station Nuclear Safety Operational Analysis. (D.C.C.)

22361 (DOCKET-50358-6) WM. H. ZIMMER NUCLEAR POWER STATION, UNITS 1 AND 2. Application for Licenses. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 6 Apr 1970. 74p. (DOCKET-50359-6). Dep. CFSTI.

Financial data on the owners of the William H. Zimmer Power Reactor Units 1 and 2 are given in support of the application for construction permit and operating license. The 1969 Annual Reports for the Columbus and Southern Ohio Electric Company, the

Cincinnati Gas and Electric Company, and the Dayton Power and Light Company are included. (D.C.C.)

22362 INTERNATIONAL ASPECTS OF APPROVAL AND SUPERVISION OF NUCLEAR ACTIVITIES. Boulanger, Werner; Phuong, Ha Vinh; McCullen, John (International Atomic Energy Agency, Vienna). pp 25-38 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The rapid increase in the number of countries operating research and power reactors and employing radioisotopes in medicine, industry, and agriculture is discussed. With this increase, the need for uniform rules and regulations on safety standards for the protection of life and property was recognized. The past and present activities of the International Atomic Energy Agency in establishing procedures for approval and supervision of nuclear activities are described. (H.D.R.)

22363 EXPERIENCE OF SAFETY IN COMMERCIAL NUCLEAR POWER PLANT IN THE UNITED KINGDOM. Griffiths, Trevor (United Kingdom Ministry of Power and Secretary of State for Scotland, London). pp 109-17 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22364 PROCEDURES IN FORCE IN FRANCE TO ASSURE THE SECURITY AND RADIOLOGIC PROTECTION OF NUCLEAR PLANTS. Vergne, Julien Armand (CEA, Paris). pp 119-30 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In French).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

Legal aspects of the regulation of French nuclear power reactors are described. Procedures used to ensure the nuclear safety of the reactors and the radiological protection of the public are discussed. (H.D.R.)

22365 LICENSING AND INSPECTION PROCEDURES FOR NUCLEAR POWER PLANTS IN THE FEDERAL REPUBLIC OF GERMANY. Kellermann, Otto A. pp 131-40 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22366 THE FUNCTION OF CNEN ON CONTROL AND SURVEILLANCE OF NUCLEAR POWER PLANTS. Battistini, Giulio (CNEN, Rome). pp 147-71 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680350.

22367 COMPETENCE OF THE INTERIOR MINISTRY IN RELATION TO NUCLEAR EMERGENCIES. Arrigo, Mario (Ministero dell'Interno, Direzione Generale della Protezione Civile, Rome). pp 185-98 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22368 PROTECTION OF THE POPULATION IN THE VICINITY OF NUCLEAR POWER PLANTS. Scanga, Francesco (Ministero della Sanita, Rome). pp 199-208 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The responsibilities of the Italian Ministry of Health in protecting the public from possible radioactive discharges are described. (H.D.R.)

22369 PRIVILEGES AND DUTIES OF THE LABOR MINISTRY WITH REGARD TO SUPERVISION OF NUCLEAR POWER PLANTS. Bessero, Carlo (Ministero del Lavoro e della Previdenza Sociale, Rome). pp 209-18 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22370 THE POSITION OF ENEL TOWARD TECHNICAL ASPECTS AND PROCEDURES OF NUCLEAR SECURITY AND HEALTH PROTECTION. Lepore, Romolo; Farulla, Antonio (ENEL, Rome). pp 219-26 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In Italian).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22371 RELIABILITY AND SAFETY OF NUCLEAR POWER STATIONS. Knecht, Othmar (Interatom, Bensberg, Ger.). At. Strom.; 16: 6-8(Jan 1970). (In German).

The probability and the damage arising from breakdowns in a prototype reactor are determined by an analytical method. The relation between these two quantities can be approximately represented by a Weibull function. The probability of breakdowns with a great release of activity is much lower than that of the usual, traditional breakdowns. The risk arising from nuclear breakdowns amounts to only a few percent of the overall risk of damage. A special nuclear risk criterion is proposed for persons. (auth)

22372 A NEW RIVER. Environment; 12: 36-41(Jan-Feb 1970).

The possible effects of thermal effluents from 16 nuclear power plants on the ecology of the Great Lakes are considered. Possible alternatives to discharging large amounts of heated water into the Great Lakes are discussed. (D.C.C.)

22373 UTILITY'S ROLE IN NUCLEAR SAFETY RESEARCH AND DEVELOPMENT. Moore, Jack B. (Southern California Edison Co., Los Angeles). Nucl. Safety; 11: 185-94(May-Jun 1970).

Planning for new electricity-generating units in large utilities is characterized by contracting for a series of similar units to be operational over a span of years before changing to a different design. Delays, caused by design changes made necessary because of equipment problems and by changing requirements in reactor licensing, upset this orderly growth and have a cascading effect so that a serious risk of electrical blackouts ensues during the transition from fossil-fueled to nuclear-fueled electricity generation. The utility's role is to assure feedback of operating experience and proper evaluation of the feed-forward to standards and criteria that occurs prior to actual operating experience. 21 references. (auth)

22374 PROTECTION INSTRUMENTATION SYSTEMS IN LIGHT-WATER-COOLED POWER-REACTOR PLANTS. O'Brien, H. G.; Walker, C. S. Nucl. Safety; 11: 206-14(May-Jun 1970). (ORNL-NSIC-29).

Current practices in protection-system designs vary widely, indicating differences in design criteria, as well as the lack of commonly recognized "best ways" in design approaches for carrying out similar functions. The design of the instrumentation systems for the engineered safety features presents a considerably more complex problem than the design of the reactor shutdown system. Examinations of the designs of four typical protection instrumentation systems for boiling- and pressurized-water power reactors indicated that designs should be effectively documented, logical and appropriate requirements for performance and reliability should be established, and detailed criteria are needed for instrumentation-system design. 32 references. (auth)

22375 ICE-CONDENSER REACTOR CONTAINMENT SYSTEM. Weems, Sterling J.; Lyman, Walter G.; Haga, P. B. Nucl. Safety; 11: 215-22(May-Jun 1970).

The ice-condenser reactor containment system employs borated ice as a static heat sink for rapid absorption of energy that might be released through rupture of reactor coolant piping. The concept is adaptable to all current types of commercial nuclear power plants. The basic design philosophy, system parameters, and full-scale-section prooftesting conducted to establish the soundness and practicality of the concept are described, as well as the first plant application. 3 references. (auth)

22376 SAFETY-RELATED OCCURRENCES REPORTED IN DECEMBER 1969-JANUARY 1970. Casto, W. R. (comp.). Nucl. Safety; 11: 240-3(May-Jun 1970).

22377 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety; 11: 266-77(May-Jun 1970).

Steam and Power Conversion Systems

22378 SULZER MONOTUBE STEAM GENERATOR FOR THE NUCLEAR POWER STATION ST. LAURENT I OF ELECTRICITE DE FRANCE. Kaegi, I. Combustion; 40: No. 2, 32-42(Aug 1968).

Integrated configurations in French reactor design with prestressed concrete vessels, Sulzer boiler and circulators for the EDF4 station are presented. Design of the steam generator modules, thermodynamic conception, project work, production and construction are described. (5 references) (auth)

Power Reactor Development

Refer also to abstracts 20936, 21341, 22468, and 22469.

22379 (AI-AEC-12791(Vol.1)) 1000-Mwe LIQUID METAL FAST BREEDER REACTOR FOLLOW-ON STUDY. CONCEPTUAL SYSTEM DESIGN DESCRIPTIONS. (Atomics International, Canoga Park, Calif.). [1969]. Contract 31-109-38-1996. 272p. Dep. CFSTI.

For Argonne National Lab., Ill.

The system requirements, design parameters, subsystems, and major components are defined for the overall plant and major segments of the 1000 MW(e) sodium-cooled reactor. Separate conceptual design descriptions are included for: (1) overall plant; (2) reactor segment; (3) reactor vessel assembly; (4) reactor vessel internals; (5) reactivity control system; (6) reactor shielding; and (7) fuel and blanket elements. (H.D.R.)

22380 (AI-AEC-12791(Vol.3)) 1000-Mwe LIQUID METAL FAST BREEDER REACTOR FOLLOW-ON STUDY. CONCEPTUAL SYSTEM DESIGN DESCRIPTIONS. (Atomics International, Canoga Park, Calif.). [1969]. Contract 31-109-38-1996. 287p. Dep. CFSTI.

For Argonne National Lab., Ill.

The design requirements and descriptions are presented for various systems and major components of the conceptual 1000 MW(e) sodium-cooled fast breeder. Systems and segments described include: (1) auxiliary systems segment; (2) reactor and intermediate coolant supply and treatment system; (3) startup, shutdown, and decay heat removal system; (4) reactor support segment; (5) subassembly handling system; and (6) land, structures, and conventional systems segment. (H.D.R.)

22381 (GA-9720) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). 29 Oct 1969. Contract AT(04-3)-633. 128p. Dep. CFSTI.

BLOWERS—stress testing of Fort St. Vrain Power Reactor Unit I
BOILERS—flow stability in Fort St. Vrain Power Reactor Unit I, testing of steam-water
CRITICALITY STUDIES—hazards analysis for Fort St. Vrain fuel element shipping container
FORT ST. VRAIN POWER REACTOR, UNIT I—remote viewing equipment for, testing of television
—remote handling equipment for, testing of reserve shutdown material vacuum
—power tilting in, effects of refueling sequence on
—kinetics of, effects of rod withdrawal accident on
—control element drives for, testing of
—blowers for, stress testing of
—turbines for, stress testing of
—loading machine for, testing of
—fuels for, radiation testing of TRISO coated,
—boilers for, testing of steam-water flow stability in
GRAPHITE—mechanical properties of Grade A H-327
NEUTRONS, FAST—effects on mechanical properties of TRISO coated thorium carbide (ThC_2)-uranium carbide (UC_2) particle type fuel
REACTIVITY—distribution in Fort St. Vrain Power Reactor Unit I, effects of refueling sequence on
REACTOR CONTROL ELEMENTS—drives for Fort St. Vrain Power Reactor Unit I, testing of
REACTOR FUELS—radiation effects on physical properties of TRISO coated thorium carbide (ThC_2)-uranium carbide (UC_2) particle type, analysis of fast neutron
REACTOR LOADING MACHINES—testing of Fort St. Vrain Power Reactor Unit I
REACTOR SAFETY—kinetics of Fort St. Vrain Power Reactor Unit I, effects of rod withdrawal accident on
SHIELDED CONTAINERS—criticality analysis for shipping Fort St. Vrain Power Reactor Unit I fuel elements
TELEVISION EQUIPMENT—testing of Fort St. Vrain Power Reactor Unit I remote viewing
THORIUM CARBIDES—ThC_2-UC_2, radiation effects on TRISO coated particle type, analysis of fast neutron
TURBINES—stress testing of Fort St. Vrain Power Reactor Unit I
URANIUM CARBIDES—ThC_2-UC_2, radiation effects on TRISO coated particle type, analysis of fast neutron
VACUUM SYSTEMS—testing of Fort St. Vrain Power Reactor Unit I reserve shutdown (D.C.C.)

22382 FAST BREEDER REACTORS: ECONOMIC AND TECHNICAL OUTLOOK AND THE PRESENT STATE OF DIFFERENT LAYOUTS, FROM THE POINT OF VIEW OF THE COOLING MEDIUM IN PARTICULAR. Ernst, Reinhard (Siemens-Schuckertwerke AG, Erlangen, Ger.); Guthmann, Elmar; Fischer, Joerg; Seetzen, Juergen. At. Strom.; 16: 19-29(Jan 1970). (In German).

The development of fast breeder reactors is described in relation to the development of nuclear power stations. From development up to the present the conditions are derived for the economic success of nuclear power stations. The economic characteristics of fast breeder nuclear power stations are considered. The present state of work on layout and development on the planning of fast breeders, which is being carried out in the German Federal Republic and the Benelux countries, is described in detail. 10 references. (auth)

22383 BOILING-WATER REACTOR: DEVELOPMENT AND DEVELOPMENT TRENDS. Kornbichler, Heinz (AEG-Telefunken, Frankfurt am Main). At. Strom.; 16: 8-12(Jan 1970). (In German).

The development of the boiling-water reactor from experimental beginnings up to the modern installations is reviewed. The development of cooling medium circulation from natural circulation to fully integrated forced circulation, the increase in power density the regulation of behavior, the constructional development from the dry pressure vessel to the pressure reduction system, and the development possibilities of the boiling-water reactor are discussed. (auth)

22384 GAS-COOLED THERMO-NUCLEAR REACTOR. Keller, W.; Stuger, R. (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 835,000. 17 Feb 1970. Priority date 29 Oct 1965, Germany.

The assembly contains a steam generator and a blower for the cooling gas, housed in a common prestressed concrete container. The reactor has a moderator vessel containing a core of heavy water over which is maintained a layer of protective gas of the same kind as the cooling medium. There are means for adjusting the moderator height in the vessel and a method for continuously cleaning the protective gas and maintaining it at a pressure of a few mm of water less than that of the cooling gas. The inner wall of the prestressed concrete container is heat-insulated and a space between the inner walls and both the steam generator and moderator vessel is provided to guide the cooling gas. (F.S.A.)

22385 HIGH-TEMPERATURE REACTOR WITH HELIUM TURBINE. Boehm, Edgar (Gutehoffnungshuette Sterkrade AG, Oberhausen, Ger.); Bammert, Karl. At. Strom.; 16: 13-19(Jan 1970). (In German).

The advantages of the helium cooled high-temperature reactor with the closed gas turbine circuit are described. As part of the Third German Energy Programme, GHH is erecting a 22-MW-nuclear power plant with high-temperature reactor and helium turbine, scheduled to go into operation in 1973 at Geesthacht/Schleswig-Holstein. To develop this type of nuclear power station still further, several helium test facilities will be set up and design work is carried out for a 600-MW-nuclear plant. 14 references. (auth)

For abstracts of individual papers see: 22246-22248, 22388-22394, 22396, 22411-22413, 22421, 22453-22462, 22491-22493, and 22504-22508.

22386 PHYSICS OF FAST REACTOR OPERATION AND DESIGN. Proceedings of an International Conference Held at London, 24-26 June 1969. London; British Nuclear Energy Society (1969). 369p. (CONF-690634).

Thirty-three papers were presented under the following sec-

tional titles: basic physics measurements with zero power reactors; steady state and dynamic performance; and operation of power reactors. Discussions are reproduced. Separate abstracts have been prepared for all the papers. (UK)

Kinetics and Dynamics

Refer also to abstracts 22459, 22461, 22496, 22504–22506, and 22508.

22387 (BNWL–1264) 3DB: A THREE-DIMENSIONAL DIFFUSION THEORY BURNUP CODE. Hardie, R. W.; Little, W. W. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 150p. Dep. CFSTI.

3DB is a three-dimensional (X-Y-Z, R-θ-Z, triangular-Z), multigroup diffusion code for use in detailed fast reactor criticality and burnup analysis. All programming is in FORTRAN-IV. Since variable dimensioning is employed, no simple restrictions on problem complexity can be stated. The code requires a 65k core and eleven peripheral storage units. Running time (for a k_{eff} calculation) on a UNIVAC 1108 is about ½ hr for a 20 × 20 × 20 mesh problem using 2 energy groups. Each successive burnup time step takes about ¼ of the above time. (5 references) (auth)

22388 CORRELATION OF INTEGRAL DATA AND CROSS SECTIONS IN INTERMEDIATE ENERGY CORES. Kuroi, H.; Mizoo, N.; Ichimori, T.; Obu, N.; Hirota, J. (Japan Atomic Energy Research Inst., Tokyo). pp 82-9 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

An analysis of criticality, fission ratio and sample reactivity worth measured in intermediate energy cores was performed by using various cross section data. Using a numerical analysis of heterogeneity effects in the resonance energy region, the calculated results agreed fairly well with the experimental results. The cross sections of the ^{235}U in the UK-Nuclear data library and ENDF/B gave satisfactory results for various integral data, but the ABBN set was found to give excessively lower reactive results in the intermediate energy region. For ^{239}Pu cross sections above 20 keV, the integral data obtained suggest that higher fission cross sections for ENDF/B, and lower fission and capture cross sections for ABBN are preferred. In the intermediate energy region, Gwin et al. data were shown to be good. For ^{238}U no definite conclusion to decrease the capture cross section in the UK-Nuclear data has been obtained so far. For stainless steel, poor agreement between experimental and calculated results of sample reactivity worth was observed, especially in the intermediate energy region. (auth) (UK)

22389 ANALYSIS AND CORRELATION OF INTEGRAL EXPERIMENTS IN FAST REACTORS WITH NUCLEAR PARAMETERS. Biteili, G.; Cecchini, G.; Gandini, A.; Salvatores, M. (CNEN, Rome). pp 157-63 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Methods of analysis of integral measurements are discussed. A method of calculating group cross sections accounting for heterogeneity effects is illustrated. This procedure, called "ABBN convention" by analogy with the well known "Westcott convention" for thermal reactors, allows information relevant to systems of different composition, without significant loss of accuracy. Conceptual integral experiments are also discussed on the basis of analytical methods developed recently. (auth) (UK)

22390 PHYSICS CONSIDERATIONS IN THE DESIGN OF, AND MOCK-UP EXPERIMENTS IN SNEAK FOR, KNK-II. Eitner, D. (INTERATOM GmbH, Bensberg, Ger.); Engelmann, P.; Ruppert, E. pp 201-12 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

KNK-II, the fast core of the 58 MW(t) Na-cooled experimental reactor KNK now under construction at Karlsruhe, will serve as a test facility for fast breeder fuel elements. A test volume of approx. 60 litres will be available. Design criteria and methods of calculation, together with some results concerning nuclear properties of this core are discussed. Also described is a three-month program of experiments which has been performed in the SNEAK facility to study the neutron physics of the KNK-II core. The experiments concentrated on the determination of critical enrichment, power distribution, Doppler coefficient, and control rod worths. (auth) (UK)

22391 SOME NEUTRONIC PROBLEMS RELATED TO PHENIX. Clauzon, P. P. (CEA, Cadarache, France); Meyer-Heine, A.; Giacometti, C.; Sacriste, C.; Jegu, J.; Sicard, B.; Lacapelle, T. pp 222-34 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-69034.

A short survey of the physics work performed at Cadarache in support of the Phénix project is given. The following are mentioned: codes developed for the Phénix project; power flattening, control problems, accuracy of the theoretical predictions (particularly as regards the critical mass); improvement of the accuracy of the predictions brought about by the integral experiments; transition from initial core loading to equilibrium core; and modification of the predicted initial core loading in order to accommodate errors in the predictions, and consequences on the transition period. (auth) (UK)

22392 PHYSICS STUDIES ASSOCIATED WITH THE BLANKET MANAGEMENT OF THE SNR REACTOR. Billaux, M.; de Meulemeester, E.; Goldschmidt, P.; Pilate, S.; Vanderberg, Cl. (Belgo Nucleaire, Brussels). pp 238-45 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Physics studies related to the radial blanket of the SNR prototype are described for different refueling policies. Synthesis methods are used combining two-dimensional diffusion calculations in cylindrical (R,Z) and plane (triangular mesh) geometries to allow adequately for the actual fuel pin layout, in particular at the core blanket boundary. Neutron transport and γ effects are also considered. From the power distribution results the flow rate in the blanket is calculated so that the mid-clad temperature does not exceed an adequate technological limit. The different refueling policies are compared from the standpoint of the flow rate savings in the blanket. (auth) (UK)

22393 EVALUATION OF THE ACCURACY REQUIREMENTS FOR CROSS-SECTIONS IN CALCULATIONS FOR FAST POWER REACTORS. Zaritskii, S. M.; Troyanov, M. F. pp 309-13 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Possible ways of evaluating the accuracy of cross-section data needed to secure the required accuracy for the calculation of reactor parameters are described. It is assumed that the results of integral experiments are not used in the determination of group cross-sections, these being obtained from differential measurements only. In other words, it is necessary to determine the required accuracy of differential cross-sections (microconstants) to secure the required accuracy in calculating reactor parameters without resort to integral experiments in determining the microconstant values. (auth) (UK)

22394 SOURCES OF PHYSICS INFORMATION REQUIRED FOR THE OPERATION OF FAST POWER REACTORS. Smith, D. C. G. (Atomic Energy Establishment, Winfrith, Eng.). pp 317-25 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

The information which is required to operate fast power reactors to the best advantage and the ways by which the information may be obtained are discussed. A limited but important amount of information may be acquired from installed reactor equipment. Additional data, particularly with regard to reactivity feedback, may be generated by the use of special apparatus; but the extent of this information is insufficient and it must be supplemented by theoretically based assessment of reaction rate distribution and reactivity perturbation effects. These assessments are currently derived from calculations, the results of which are suitably adjusted in the light of information obtained from a lower power simulation experiment. With the expected improvements in methods and data, the need for these expensive experiments will diminish although, in order to realize some of the development potential of fast reactors, the demanded assessment accuracy may increase and thereby delay the time when simulation experiments become unnecessary. Progress on SEFOR is described. (auth) (UK)

Control Systems

22395 (ANL–7558) EXPOSED-FUEL CALIBRATION STUDY IN EBR-II, SECOND SERIES. Smith, R. R.; Doe, C. B.; Ebersole,

E. R. (Argonne National Lab., Ill.). Jan 1970. Contract W-7405-eng-38. 46p. Dep. CFSTI.

Fission-product detection in the EBR-II system is annunciated by the FGM and FERD systems and by another method based on the radiometric assay of cover-gas samples for ^{133}Xe and ^{135}Xe. The FGM continuously monitors the concentrations of short-lived rare gases (^{85}Kr, ^{88}Kr, and ^{138}Xe) in the cover gas; the FERD senses the level of delayed-neutron-emitting fission products in a bypass coolant stream. The first two systems are on line and provide a continuous record for the respective index species. The third technique periodically analyzes samples for ^{135}Xe and ^{135}Xe. Under normal operating conditions, each system registers a response proportional to the power level and to the degree of system contamination by "tramp" uranium. Deliberate introduction of exposed-fuel material increases the signals from all three systems. Defining "tramp" background as noise, and the increased response from the exposed fuel as "signal," the signal-to-noise ratio (S/N) for all three systems should be identical and independent of reactor power. Definitive tests, based on deliberate insertion of unclad fuel material, indicated an average S/N ratio of 3.9 for the FERD and FGM systems for a single fuel pin in the Row-5 position. Lower values of the S/N ratio, based on longer-lived index species, indicated the presence of a defective fuel element that was exchanging bond sodium intermittently with flowing primary coolant. The ratio of power generated in a control rod in its withdrawn position to that with the rod fully inserted was 0.52; the upper limit of the effective dissolution rate of U-5 Fs fuel material in hot Na was 2.7 mg of uranium per day per pin. Measurement of the radiological importance of cover-gas leakage during tests showed no significant change in radiation levels. Therefore, insofar as radiological aspects are concerned, continuous operation of EBR-II with at least two defective driver-fuel elements appears to be possible. 8 references. (auth)

22396 STUDIES ON THE SNR CONTROL ROD SYSTEM. Joest, K. H.; Heinecke, J.; Huebel, H.; Loehr, W.; Beliczey, St.; Wiesenberg, G. (INTERATOM GmbH, Bensberg, Ger.). pp 295-8 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

A review of design criteria and characteristic data for the SNR control rod system is presented. (auth) (UK)

Cooling Systems

22397 (AI-AEC-12791(Vol.2)) 1000-Mwe LIQUID METAL FAST BREEDER REACTOR FOLLOW-ON STUDY. CONCEPTUAL SYSTEM DESIGN DESCRIPTIONS. (Atomics International, Canoga Park, Calif.). [1969]. Contract 31-109-38-1996. 212p. Dep. CFSTI.

For Argonne National Lab., Ill.

The heat transfer and energy conversion systems requirements, design parameters, subsystems, and major components are defined for the 1000 MW(e) sodium-cooled reactor. Separate conceptual design descriptions are included for: (1) heat transfer segment; (2) reactor coolant system; (3) reactor sodium pumps and drives; (4) reactor sodium valves; (5) intermediate coolant system; (6) intermediate system sodium pumps and drives; (7) intermediate sodium valves; (8) intermediate heat exchangers; (9) steam generation system; (10) energy conversion system; and (11) control and instrumentation system. (H.D.R.)

22398 VGB-SPEISEWASSERTAGUNG 1968. (VGB Feedwater Conference 1968. Conference Held at Essen, Germany, October 1968). Essen, VGB-Dampftechnik GmbH (1968). 70p. (CONF-681074).

The ten papers presented at the VGB Feedwater Conference in 1968 are compiled. Individual abstracts were prepared for two of the papers. (J.S.R.)

For abstracts of individual papers see: 22399 and 22400.

22399 METHODS AND DEVELOPMENTS IN CONDENSATE AND FEED WATER CONDITIONING. Heitmann, H. G. (Siemens-Schuckertwerke AG, Erlangen, Ger.). pp 43-53 of VGB-Speisewassertagung 1968. Essen; VGB-Dampftechnik GmbH (1968). (In German).

From VGB Feedwater Conference, Essen, Germany. See CONF-681074.

Recent improvements in the methods and techniques of condensate and feed water conditioning are reviewed. The improvements in the physical processing are chiefly concentrated in the filters and the introduction of magnetic methods. In the chemical processing the principal developments are the multilayer exchanger and the settling filter. The circuitry of the condensate conditioning is given. The introduction of the condensate or feed water conditioning into water circuits is outlined. (9 references) (J.S.R.)

22400 CONDENSATE PROCESSING IN GUNDREMMINGEN NUCLEAR POWER PLANT. Schroeder, H. J. (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmmingen, Ger.). pp 53-60 of VGB-Speisewassertagung 1968. Essen; VGB-Dampftechnik GmbH (1968). (In German).

From VGB Feedwater Conference, Essen, Germany. See CONF-681074.

The use of mixed bed filters for a quantitative and continuous, simultaneously mechanical and chemical purification of the condensate of a 250-MW(e) nuclear power plant was shown to be practical and economical. Interferences and difficulties can be controlled without interruption of the reactor operation. The data obtained on the operation of this installation should permit the use of similar installations in the future. (13 references) (tr-auth)

22401 IMPROVEMENTS IN OR RELATING TO GAS CIRCULATORY MEANS: FOR EXAMPLE FOR GAS-COOLED NUCLEAR REACTORS. Cockburn, David Mark (to C. A. Parsons and Co., Ltd.). British Patent 1,183,038. 4 Mar 1970. Filed 29 Sep 1966.

Reference is made to means for circulating coolant gas within a nuclear reactor of concrete pressure vessel type. The gas circulators are conveniently mounted in radial tunnels in the pressure vessel walls, the outer ends of the tunnels being sealed during reactor operation. A sleeve valve arrangement is provided, having a fixed ported member for location in the pressure vessel wall and a ported sleeve adapted to slide within the fixed ported member. The gas circulator and its driving means are removably mounted within the sleeve, and movement of the sleeve in the direction of its central axis opens and closes ports in the valve arrangement in order to permit or prevent passage of gas through the circulator and at the same time seal off the space within the sleeve from the gas within the pressure vessel. The fixed ported member may have an end portion of enlarged inner diameter for protrusion into the pressure vessel, this end portion having two axially spaced rings of ports which co-operate with two axially spaced rings of ports in the sleeve. The end portion of the sleeve is closed and of enlarged outer diameter so as to slide in the end portion of the fixed member. The intermediary member is adapted to lie between the axially spaced rings of ports when the valve arrangement is in the open position, but to seal off the axially outermost ring of ports in the fixed member and the axially innermost ring of ports in the sleeve when the valve arrangement is in the closed position. (UK)

22402 IMPROVEMENTS IN HEAT EXCHANGE APPARATUS. Russell, Charles Michael Buchanan; Kelly, John Joseph (to Lummus Co.). British Patent 1,183,220. 4 Mar 1970. Filed 5 Oct 1967.

Reference is made to heat exchangers for liquid metal cooled nuclear reactors. Baffles are provided in the outer container below the normal liquid level, causing a sinuous flow of primary liquid from the outer to the inner container and avoiding vortex formation. Details are given of the baffle system construction. The reactor may be spaced from the liquid metal containers and be included in a closed circuit through which primary liquid is pumped to and from the outer container through the reactor core. (UK)

Fuels

Refer also to abstracts 20968, 20974, 22446, and 22498.

22403 (ANL-7602) POSTIRRADIATION EXAMINATION OF U-Pu-Zr FUEL ELEMENTS IRRADIATED IN EBR-II TO 4.5 ATOMIC PERCENT BURNUP. Murphy, W. F.; Beck, W. N.; Brown, F. L.; Koprowski, B. J.; Neimark, L. A. (Argonne National Lab., Ill.). Nov 1969. Contract W-31-109-eng-38. 61p. Dep. CFSTI.

Sixteen U-15 wt % Pu-10 wt % Zr metallic fuel elements were irradiated to 4.5 at. % burnup at 10 kW/ft without failure. Cladding materials were Types 304L and 316 stainless steel, Hastelloy-X, and Hastelloy-X-280. The maximum cladding temperatures ranged from 605° to 650°C. Diametral and axial expansion of the cladding were both less than 0.3%. The fuel had swelled to the cladding, and 14 of the fuel columns elongated and two decreased in length. The interface between the fuel and the cladding showed evidence of a reaction between the two. The smallest reaction layer (~1 mil) was in the Type 316 stainless steel. Annular zones had developed in the fuel. These zones are principally temperature dependent and are probably associated with phase transformations in the fuel. Fission products and major fuel constituents were found to have migrated between the three zones. (23 references) (auth)

22404 (BMBW-FBK-69-46) DEVELOPMENT PROGRAMME: FAST CORE FOR THE SUPERHEATER REACTOR (HDR). CONCLUDING REPORT. Stumpe, A. C. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany)). Dec 1969. 134p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED DM 28.15

Development and project investigations analysing the possibilities of a reconstruction of the superheat reactor HDR as a test-bed for fuel rods of steam cooled fast reactors are reviewed. The plan of a second core for the HDR consisting of an outer thermal and a central fast zone ran into difficulties concerning safety aspects. The intention of fitting a small steam cooled fast reactor into the HDR-pressure vessel turned out as unproportionally expensive. Therefore the plan of reconstructing the HDR was dropped in favor of an independent test reactor. (7 references) (auth)

22405 (GEAP-13556) BICYCL: A COMPUTER CODE FOR TWO-DIMENSIONAL ANALYSIS OF EQUILIBRIUM FUEL CYCLES. Vaughan, P. C.; Butz, H.; Greebler, P.; Hutchins, B. A.; Kelley, M. D.; Reynolds, A. B. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Dec 1969. Contract AT(04-3)-189. 225p. Dep. CFSTI.

The BICYCL computer program for calculating fast reactor fuel cycles is presented. The program is written in FORTRAN 4 for the GE-635 computer. The program computes spatially-dependent fuel isotopic compositions consistent with recycling of discharged fuel and reactivity requirements. First order perturbation theory is used to compute fuel cycle reactivity values. Program limitations are described. 4 references. (D.C.C.)

22406 (ORNL-TM-2850) DESIGN, EQUIPMENT, AND PROGRAM FOR FUEL ROD BURST EXPERIMENTS. Osborne, M. F.; Parker, G. W. (Oak Ridge National Lab., Tenn.). 2 Feb 1970. 27p. Dep. CFSTI.

Irradiated Zircaloy-clad fuel rods will be rupture-tested to study the effects of irradiation on the failure characteristics of the cladding. A system has been constructed in a hot cell, and burst experiments on both unirradiated and irradiated fuel rods are being conducted under conditions predicted for a Loss-of-Coolant Accident in a water cooled power reactor. (9 references) (auth)

22407 (RT/ING-(69)30) VENTING DEVICE FOR SODIUM-COOLED FAST CERAMIC REACTOR FUEL ELEMENTS. Gerosa, A.; Martini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Oct 1969. 5p. (RVP-UTS-(69)3; CONF-681101-44). Dep. CFSTI (U. S. Sales Only).

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The experimental and theoretical analysis of two hydraulic venting devices for liquid Na-cooled fast ceramic reactor gaseous fission products is presented. The design of these hydraulic vents is based on placing a gas reservoir on top of each fuel pin to allow gas volume contraction during operation while preventing Na reentry. The "diving bell" with a capillary for inlet of gases into the reservoir and holes for outlet to Na and a device called "DISCA" with inlet and outlet capillaries are described. (D.C.C.)

22408 (WARD-4135-3) FAST REACTOR FUEL PERFORMANCE MODEL DEVELOPMENT. Boltax, A.; Murray, P.; Biancheria, A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Feb 1970. Contract AT(30-1)-4135. 28p. Dep. CFSTI.

The status of fast reactor fuel performance model development, involving the OLYMPUS and CYGRO-F codes is reviewed. Input information in several critical areas is examined including the swelling, irradiation creep, and ductility of stainless steel cladding; and the swelling and plasticity of mixed oxide fuel. The predictions from the two codes are illustrated by parametric studies and application to high fluence/burnup ratio fuel rods of interest to the Liquid Metal Fast Breeder Reactor (LMFBR) Program. (auth)

22409 (WCAP-3850-5) CVTR FISSION GAS RELEASE. Letter Report. Balfour, M. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Jan 1970. Contract AT-(30-1)-3850. 10p. Dep. CFSTI.

Fission gas release data are summarized on 19 fuel rods irradiated in the Carolinas-Virginia Tube Reactor. Three rods were from the regular CVTR core and had average burnups exceeding 14,000 MWD/MTU The remaining rods were from experimental assemblies and had burnups less than 8,100 MWD/MTU. The design parameters of the rods are presented, and the fission gas analysis data, average burnup, full-power hours, peak power levels, fractional release of fission gases, and power distributions are tabulated. (H.D.R.)

22410 FULL-SCALE LOOP STUDIES OF BHWR AND BWR FUEL ASSEMBLIES. Nylund, Olov (Aktiebolaget ASEA-ATOM, Vasteras, Sweden). ASEA (Allm. Sv. Elek. A. B.) Res.; 10: 63-125(1969).

A series of full-scale loop studies of the hydrodynamic and heat-transfer behavior of boiling-water reactor fuel assemblies is described. The present program includes tests for heavy-water reactors, with special reference to the Marviken BHWR type, as well as light-water reactors, using the Oskarshamn BWR type as a reference design. There were extensive investigations with natural or forced circulation at a maximum power of 8 MW and a maximum pressure of 100 bars. Measurements include axial and radial void distribution, single- and two-phase pressure drop, natural-circulation mass velocity, stability limits as well as detailed dynamic characteristics, and burn-out under steady-state or transient conditions. (auth) (Sweden)

22411 CONSIDERATIONS OF DETAIL IN PHYSICS DESIGN AND FUEL MANAGEMENT OF FAST POWER BREEDER REACTORS. Adamson, J. (Atomic Energy Establishment, Winfrith, Eng.); Mann, J. E.; Perks, M. A. pp 246-56 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

A number of topics are considered relevant to the finer points of design and operation of fast breeder power reactors containing hexagonal fuel elements. Alternative fuel management procedures for start-up and establishment of a fuel cycle for a 250 MW(e) reactor are discussed. Other fuel management topics discussed concern the questions of maximum utilization of the first charge, the effects of fuel element failures, fuel shuffling, fuel rotation and differential control rod movement, and the consequences of a change in allowable fuel burn-up and in fuel type. The effects of mesh geometry on calculated fuel element ratings and the worths of absorber rods are investigated. For a larger reactor the effects of varying the number and geometry of enrichment zones are considered. The possibility of using control rods containing fuel, instead of absorber only, is re-examined to assess the consequent improvement in breeding gain. (auth) (UK)

22412 ANALYSIS OF THE LONG-TIME BURNUP BEHAVIORS OF FAST REACTORS WITH A CLOSED FUEL CYCLE. Yoshida, H.; Hirata, M. (Japan Atomic Energy Research Inst., Tokai). pp 257-71 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

A simple method is developed for analyzing the long-time burnup characteristics taking into account the maximum permissible burnup and reactivity loss. The reactivity loss is estimated by the first-order perturbation theory, and the burnup is evaluated on the assumption that time-dependent neutron flux is expressed by the separation of variables with respect to space and time. The method is applied to a typical Na cooled 1000 MW(e) fast reactor, and the numerical results are given, compared with those of the two-dimensional burnup calculations. (auth) (UK)

22413 PERFORMANCE OF A STEP-CORE GEOMETRY FOR A FAST BREEDER REACTOR. Spenke, H.; Schatz, M.; Stojadinovic, A. (Siemen-Schuckertwerke AG, Erlangen, Ger.). pp 291-4 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

It is stated that wrapper tube fuel elements for Na cooled fast breeders encounter several problems of mechanical design, which could be overcome by using open fuel elements. The performance of a step-core geometry with open elements is investigated with respect to void safety, power distribution and cooling properties and fuel cycle costs. For all these aspects satisfactory results are found. Taking into account some additional advantages, it is concluded that a step-core geometry with open fuel elements should be considered attractive for the core design of Na cooled fast breeders. (auth) (UK)

22414 IMPROVEMENTS IN AND RELATING TO SUPPORT MEANS FOR A NUCLEAR REACTOR. (to Societe des Forges et Ateliers du Creusot). British Patent 1,185,320. 25 Mar 1970. Priority date 30 Dec 1966, France.

REACTORS, GAS-COOLED — core support structure for, design of graphite block separated metal plate (D.C.C.)

22415 CORE SUPPORT STRUCTURE FOR NUCLEAR REACTOR. Eagle, John (to English Electric Co., Ltd.). British Patent 1,181,521. 18 Feb 1970. Filed 20 May 1966.

Reference is made to nuclear reactors in which a moderator core is supported in and spaced from the floor of a concrete pressure vessel by a core support structure. In the system described the support structure includes a number of thermally insulating load bearing support pads, each such pad comprising an outer casing containing a number of metal sheets disposed parallel to the pressure vessel floor and arranged so as to define voids between adjacent sheets. The support pads may be disposed in apertures in the pressure vessel thermal insulation and supported on the metal liner of the pressure vessel. The moderator core may be supported on pillars which are in turn supported endwise on the support pads and the pillars adapted to rock so as to permit limited relative transverse movement between the moderated core and the pressure vessel. Cooling fluid ducts may be provided in the pressure vessel in contact with the metal liner adjacent to the pads supporting the pillars. At least every alternate metal sheet in the support pads may be corrugated. (UK)

22416 NUCLEAR REACTOR STRUCTURE. Prince, Norman; Coast, Geoffrey (to United Kingdom Atomic Energy Authority). British Patent 1,182,588. 25 Feb 1970. Filed 8 Aug 1966.

Reference is made to support means for a graphite moderated reactor core and associated neutron top shield. In the system described the core and top shield structure comprises a core support diagrid, columns of graphite moderator blocks supported on this diagrid, a top shield support diagrid above these graphite blocks, a top shield consisting of columns of graphite blocks overlaid by a neutron absorbing thermal shield and supported on the top shield support diagrid, and a member defining between this support diagrid and the top shield a re-entrant moderator coolant plenum. The plenum is penetrated by tubes for conducting coolant from channels in the graphite moderator blocks through the member and discharging it into a coolant outlet plenum above the member. The top shield support diagrid is located below the re-entrant coolant plenum and the member is integral with the top shield support diagrid. The top shield is thus supported on a rigid and flat diagrid and cannot sag due to any differential shrinkage of the columns of the graphite core moderator due to irradiation. (UK)

22417 IMPROVEMENTS IN OR RELATING TO NEUTRON MODERATING CORE ELECTRODES. Bennett, John Charles (to Atomic Power Constructions Ltd.). British Patent 1,182,665. 4 Mar 1970. Filed 9 Mar 1967.

A problem with graphite moderated nuclear reactors is that some of the columnar graphite blocks may become distorted by irradiation. In order to maintain lateral alignment of the blocks, despite distortion, it has been proposed to anchor them by upwardly extending keys disposed between the columns and extending within keyways in the side surfaces of the blocks of adjacent columns. In order to accommodate distortions in horizontal directions the keys are given clearances in the keyways; these clearances may result in a step in the channel between adjacent blocks through misalignment of the channel in these blocks, or may cause undesirable shearing forces between some of the blocks. These problems are particularly acute in regions where the neutron flux distributions across the blocks has the largest variations since the blocks in such regions are liable to distort to a larger extent than in other regions. In the system described adjacent blocks in at least some of the graphite columns are interlocked by at least four projections formed on an end surface of one block with corresponding recesses in an end surface of the adjacent block; at least two of the projections are load bearing. (UK)

Operation and Economics

22418 (DOCKET-50231-43) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Quarterly Plant Operation Report No. 3, November 1, 1969–January 31, 1970. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 30 Mar 1970. 14p. Dep. CFSTI.

22419 ARE NUCLEAR PILOT PLANTS REPLACEABLE IN THE NATIONAL ECONOMY. Eitz, A. W. (Gesellschaft fuer Kernforschung mbH: Leopoldshafen, Ger.); Tebbert, H.; Peuster, K. Atomwirt., Atomtech.; 15: 42-5(Jan 1970). (In German).

Certain nuclear power stations already are economically competitive and feasible. To develop new types of reactors, experimental and pilot installations are constructed in Germany with considerable cost to the government. The economic feasibility of the exploratory undertakings is analyzed. Since by 1980 nuclear power will produce about 50% of the electricity demand in Germany, the potential cost savings completely justify present expenditures for installations even if a certain amount of failures is encountered. (H.B.G.)

22420 ^{238}Pu PRODUCTION IN THTR FUEL ELEMENTS. Drescher, H. P. (Technische Hochschule, Aachen); Hecker, R. Atomwirt., Atomtech.; 15: 66-7(Feb 1970). (In German).

Despite its high cost, the demand for ^{238}Pu increases constantly because of its excellent suitability as an energy source in isotope generators. ^{238}Pu is the daughter product of ^{237}Np. Isolation of the two isotopes from irradiated fuel elements of a thorium high-temperature reactor at 300 MW(e) considerably lowers the cost of the fuel cycle. This conclusion is based on calculations for a prototype reactor in the planning stage. (tr-auth)

22421 RECENT OPERATING EXPERIENCE WITH EBR-II. Smith, R. R.; Cushman, R. A.; Hyndman, R. W.; Kirn, F. S.; Long, J. K.; Loewenstein, W. B.; Madell, J. T.; Bump, T. R.; Persiani, P. J. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). pp 354-61 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

During the past three years the most noteworthy matters concerned with the operation of EBR II have been a marked change in the nature of the power coefficient and the onset of a series of fission product releases. As the result of considerable analytical effort the change in the power coefficient was identified with thermomechanical deformational effects in a stainless steel reflector which was installed during 1967. Reversed thermal gradients in the outer row of the two-row reflector caused mechanical action which, in turn, modified the power coefficient by restricting the normal outward "flowering" of the core at upper elevations while augmenting the normal inward bowing of fuel subassemblies at core midplane. At least three, and possibly as many as five, cladding defects were noted. Of these, only one has been identified as being associated with a driver element and two have been identified as being associated with encapsulated experimental fuel elements. Each of the failures has led to a better understanding of annunciation and diagnostic problems, and in addition has provided a practical means of assurance that cladding defects may occur without inflicting damage to the system. (auth) (UK)

Safety and Siting

Refer also to abstract 20844.

22422 (BNWL-1244) REMOVAL OF IODINE AND PARTICLES FROM CONTAINMENT ATMOSPHERES BY SPRAYS: CONTAINMENT SYSTEMS EXPERIMENT INTERIM REPORT. Hilliard, R. K.; Coleman, L. F.; Linderoth, C. E.; McCormack, J. D.; Postma, A. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 217p. Dep. CFSTI.

The experimental data obtained in five spray experiments in the Containment Systems Experiment (CSE) are reported in detail. The performance of caustic-borate sprays in decontaminating the containment atmosphere of elemental iodine, methyl iodide, particulate iodine, cesium, and uranium is discussed in terms of theoretical models. Parameters investigated were spray flow rate, spray drop size, atmosphere temperature and pressure, and chemical composition of the spray solution. Removal rates were in agreement with predictions by mathematical models based on mean spray drop diameters. Large concentration reduction factors (>1000) were obtained for all species except methyl iodide, which was removed only slowly by the caustic sprays. Based on these experiments, the models predict 2-hr time-integrated dose reduction factors attributable to continuous sprays in a large power reactor building ranging from 1.5 for methyl iodide to 50 for elemental iodine, with intermediate values for cesium, uranium, and particulate iodine. 48 references. (auth)

22423 (BNWL-1315-1) NUCLEAR SAFETY QUARTERLY REPORT FOR USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY, NOVEMBER, DECEMBER 1969–JANUARY 1970. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 148p. Dep. CFSTI.

ACOUSTIC EMISSION TESTING — pipe failure detection by, development of system for
AEROSOLS — removal from Containment Systems Experiment, effectiveness of internal recirculating air filters for
CALCINATION — spray equipment and procedures development for radioactive waste solution solidification
CESIUM — sorption by charcoal
CHARCOAL — sorptive properties for cesium and methyl iodide
CONTAINMENT SYSTEMS EXPERIMENT — air cleaning tests in, analysis of internal recirculating
— blowdown tests in, measurement of residual water in vessel after, (E/T)

CRACKS—detection in mild steel pipes, acoustic emission method for
FILTERS—performance of Containment Systems Experiment internal recirculating air, for aerosols
GAMMA RADIATION—dose measurements from reactor accidents, effects of meteorological conditions on
GLASS—production of phosphate, for fixation of radioactive wastes
IODINE—phase distribution for, effects of containment sprays on gas–liquid
METHANE, IODO-—sorption by charcoal
NEUTRONS, FAST—effects on tensile properties of HSST A533 steel
PIPES—cracks in mild steel, acoustic emission method for detection of
RADIOACTIVE WASTE—fixation by conversion to phosphate glass, evaluation of test runs for
—solidification of solutions of, spray calcine development for
REACTOR SAFETY—aerosol removal in Containment Systems Experiment, performance of internal recirculating air filters for
—blowdown tests in Containment System Experiment, measurement of residual water in vessel after, (E/T)
—gamma doses to environment from accidents, effects of meteorological conditions on
REACTORS, POWER—thermal effluents from, effects on rivers of
STEEL—radiation effects on tensile properties of HSST A533, measurement of fast neutron
SURFACE WATERS—heating of, effects of power reactor thermal effluents on (D.C.C.)

22424 (DOCKET-50231-44) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Operator Retraining Program. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 31 Mar 1970. 4p. Dep. CFSTI.

22425 (EURFNR-703) FAUN-Z: CALCULATION OF MAJOR REACTOR ACCIDENTS BY THE MODIFIED BETHE-TAIT-METHOD IN r,z GEOMETRY. Thurnay, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1044. 59p. Dep. CFSTI.

Work performed under United States–Euratom Fast Reactor Exchange Program.

FAUN-Z is written for the IBM-7074 in FORTRAN-2. The program is used to calculate serious excursions in a cylindrical two-region core by the modified Bethe–Tait method. The program consists of the excursion program EXQ, two auxiliary programs for calculating the mean fuel temperature and the energy yield (TREF and EVØNQ respectively) and various subroutines. (auth)

22426 (GEAP-13543) MOLTEN FUEL MOVEMENT IN TRANSIENT OVERPOWER TESTS OF IRRADIATED OXIDE FUEL. Hikido, T.; Field, J. H. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Sep 1969. Contract AT(04-3)-189. 44p. Dep. CFSTI.

Results are presented on an experimental program in which were investigated the effects of molten fuel movement and fission product gases (using prototypic fuel and blanket lengths) on transient failure energy thresholds and mechanisms. Two experimental capsules were operated, first in the GETR (steady-state) and then in the TREAT (transient) facilities. The slightly enriched UO_2 fuel specimens, 0.250-inch o.d. and stainless steel clad, were compared with regard to fuel temperatures, mechanical deformations, and post-irradiation appearance. Provision for accommodation of molten fuel expansion and for internal pressure relief significantly increased the energy threshold for failure of irradiated oxide fuel pins caused by power transients. (auth)

22427 (IDO-17303) LOFT PROGRAM OFFICE. Quarterly Technical Report, April 1–June 30, 1969. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar 1970. Contract AT(10-1)-205. 123p. Dep. CFSTI.

COATINGS—performance of stainless steel containment structure, effects of iodine and methyl iodide penetration on, (E)
HEAT TRANSFER SYSTEMS—performance of pressurized water reactor, effects of blowdown conditions on, (E)
IODINE—penetration of stainless steel containment structure coatings, (E)
METHANE, IODO-—penetration of stainless steel containment structure coatings, (E)
RARE GASES—release in uranium oxide (UO_2) rod type fuel elements, effects of burnup on, (E)
REACTOR CONTAINMENT SYSTEMS—pressure profiles in pressurized water reactor emergency core cooling system, effects of blowdown on
REACTOR CONTAINMENT STRUCTURES—coatings for stainless steel, iodine and methyl iodide penetration of, (E)
REACTOR FUEL ELEMENTS—fission gas release in uranium oxide (UO_2) rod type, effects of burnup on, (E)
REACTOR SAFETY—blowdown in pressurized water reactors, calculation and measurement of pressure profiles during
—engineered safeguards for power reactors, STRAP computer program for performance analysis of
REACTOR SAFETY EXPERIMENTS—blowdown in LOFT scale model tests, measurement of pressure profiles during
—blowdown in LOFT scale model tests, RELAP 3 and WHAM computer programs calculation of pressure profiles during
REACTORS, POWER—engineered safeguards for, STRAP computer program for performance analysis of
REACTORS, PRESSURIZED-WATER—blowdown in, pressure profiles in emergency core cooling system during
—cooling system of, effects of blowdown conditions on, (E)
—emergency core cooling systems for, effects of blowdown on pressure profiles in
—coolant loss in, effects on Zircaloy-4 tubes of
TUBES—performance of Zircaloy-4, during pressurized water reactor coolant loss conditions, (E)
ZIRCALOY-4—tubes of, effects of pressurized water reactor coolant loss conditions on, (E) (D.C.C.)

22428 (LMEC-Memo-69-7(Vol.1)) FAILURE DATA HANDBOOK FOR NUCLEAR POWER FACILITIES. A GUIDE FOR THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF NUCLEAR POWER PLANTS FROM A RELIABILITY IMPROVEMENT STANDPOINT. VOLUME I. FAILURE DATA AND APPLICATIONS TECHNOLOGY. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 15 Aug 1969. Contract AT-(04-3)-700. 735p. Dep. CFSTI.

Records on past unscheduled events with systems and components in liquid metal cooled facilities are presented. The events relate to construction schedule or cost, safety, availability, or maintainability of a nuclear power plant or test facility. Broad topics include: failures occurring during facility operation; adverse events occurring prior to startup; reliability and availability analysis; and maintainability. (D.C.C.)

22429 (LMEC-Memo-69-7(Vol.2)) FAILURE DATA HANDBOOK FOR NUCLEAR POWER FACILITIES. A GUIDE FOR THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF NUCLEAR POWER PLANTS FROM A RELIABILITY IMPROVEMENT STANDPOINT. VOLUME II. FAILURE CATEGORY IDENTIFICATION AND GLOSSARY. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 20 Jun 1969. Contract AT-(04-3)-700. 191p. Dep. CFSTI.

Records on past unscheduled events with systems and components in liquid metal cooled facilities are presented. The events relate to construction schedule or cost, safety, availability, or maintainability of a nuclear power plant or test facility. Broad topics include: system or component and failure category identification; and glossary. (D.C.C.)

22430 (NACAR-10003) REVIEW OF METHYL IODIDE ISOTOPIC EXCHANGE UNDER ACCIDENT CONDITIONS. Kovach, J. Louis (North American Carbon, Inc., Columbus, Ohio. Research and Development Dept.). 1 Dec 1968. 61p.

A careful analysis of available data on the performance of iodine impregnated carbons, the test methods used for these evaluations, and the appropriate properties of carbons, leads to the conclusion that this process is effective in the decontamination of methyl iodide. At the design conditions following the hypothetical reactor accident, the decontamination process is still effective in the 100% relative humidity environment, showing radioactivity removal efficiencies on the order of 70% or better per single pass of the air-steam vapor mixture. It is recognized that carbon beds may under very exceptional conditions become temporarily flooded with water, which reduces the activity removal efficiency, but properly designed air handling systems, consisting of moisture separators and HEPA filters, will prevent water droplet carrythrough to the carbon bed. Moreover, were one to assume a mechanism whereby flooding could occur, a properly designed carbon filter bed and housing will permit the entrained water to drain and thereby restore the filter's efficiency for decontamination. 33 references. (auth)

22431 (ORNL-4511) NUCLEAR SAFETY PROGRAM. Annual Progress Report for Period Ending December 31, 1969. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 233p. Dep. CFSTI.

CARBON (SURFACE-ACTIVE)—sorptive properties for methyl iodide in air–steam
—sorptive properties for methyl iodide, effects of weathering on
CESIUM ISOTOPES Cs-137—release from failed BISO and TRISO coated uranium oxide (UO_2) and thorium carbide (ThC_2)–uranium carbide (UC_2) particle type fuels
CHARCOAL—combustion of, effects of fission product decay heat on
DATA ACQUISITION CENTERS—operations of Nuclear Safety Information Center during January to December 1969
FILTER MATERIALS—sorptive properties for stainless steel–uranium oxide (UO_2) and uranium oxide (UO_2)–zirconium oxide (ZrO_2) aerosols
GRAPHITE—corrosion by steam under high temperature gas cooled reactor accident conditions, (E/T)
HEAT TRANSFER SYSTEMS—piping diagrams for LMFBR program Failed Fuel Mockup
—design parameters for LMFBR program Failed Fuel Mockup
ICE—sorptive properties for iodine and methyl iodide
INFORMATION CENTERS—operations of Nuclear Safety Information Center during January to December 1969
IODINE—sorption by ice
—removal by NSPP spray system
IODINE ISOTOPES I-131—release from failed pyrolytic carbon coated uranium carbide (UC_2) and uranium oxide (UO_2) particle type fuels
METHANE, IODO-—sorption in air-steam by iodized charcoal
—sorption by surface active carbon, effects of weathering on
—removal by basic borate spray solutions, effects of temperature on
—sorption by ice
—removal by NSPP spray system
NOZZLES—stress in multiple spherical shell connected, effects of configuration on
NUCLEAR SAFETY PILOT PLANT—spray systems in, iodine and methyl iodide removal by
PIPE FITTINGS—stress analysis for T-shaped cylinder
PIPES—stress analysis for stepped cylinder
REACTOR FUEL ELEMENTS—failure of Zircaloy clad uranium oxide (UO_2) rod type, effects of coolant loss on, (E)
REACTOR FUELS—failure of pyrolytic carbon coated uranium carbide (UC_2) and uranium oxide (UO_2) particle type, iodine-131 release from
—failure of BISO and TRISO coated uranium oxide (UO_2) and thorium carbide (ThC_2)–uranium carbide (UC_2) particle type, cesium-137 release from
REACTOR SAFETY—research and development program during January to December 1969, analysis of ORNL
—standards for development of water cooled reactors
REACTOR SAFETY EXPERIMENTS—fuel element failure in TREAT, effects of coolant loss on Zircaloy clad uranium oxide (UO_2) rod type, (E)
REACTORS, GAS-COOLED—fuel elements for high temperature power, fission product release from failed
REACTORS, POWER—fuel elements for high temperature gas cooled, fission product release from failed
SPRAYS—stability of iodine and methyl iodide adsorbing, analysis of chemical, radiation, and thermal
STAINLESS STEEL—stainless steel–UO_2, aerosols of, performance of filter materials for adsorption of
STEAM—corrosive effects on graphite under high temperature gas cooled reactor accident conditions, (E/T)
STEEL—mechanical properties of plate shaped HSST, effects of thickness on
—radiation effects on mechanical properties of AS33 HSST, fast neutron
TUBES—failure of Zircaloy-4, testing for high temperature, (E)
URANIUM OXIDES UO_2—stainless steel–UO_2, aerosols of, performance of filter materials for adsorption of
—UO_2–ZrO_2, aerosols of, performance of filter materials for adsorption of
WELDED JOINTS—stress analysis for T-shaped cylinder
ZIRCALOY-4—tubes of, testing for high temperature failure of, (E)
ZIRCONIUM OXIDES—UO_2–ZrO_2, aerosols of, performance of filter materials for adsorption of (D.C.C.)

22432 (RT/ING-(69)29) SODIUM BOILING RESEARCHES RELATED TO FAST REACTOR SAFETY. Pinchera, G. C.; Tomassetti, G.; Falzetti, L.; Fornari, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Oct 1969. 4p. (RVP-UTS-(69)2; CONF-681101-45). Dep. CFSTI (U. S. Sales Only).

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

Loss of flow and power transients related to Na voiding in a cluster of simulated fuel rods is analyzed. Inception of boiling, liquid ejection, and reentry are investigated by integral Na forced-convection experiments and separate tests on particular aspects such as liquid Na superheat and two-phase flow pattern. (D.C.C.)

22433 (WASH-1146) WATER-REACTOR SAFETY PROGRAM PLAN. (Idaho Nuclear Corp., Idaho Falls). Feb 1970. 270p. Dep. CFSTI.

The document consists of three parts. The first part is a general discussion of the AEC Water-Reactor Safety Program, and consists of descriptions and explanations of the safety program objectives, the rationale upon which the plan is based, the organization of the program plan, and the bases upon which priority assignments have been made. The second part is a summary that is intended to satisfy the needs of managerial-level people for a concise description of the elements of the safety program. The third part is the presentation of the program plan proper. In this, the overall problem of reactor safety has been first divided into several general areas of interest; the general areas are then further divided into specific problem areas. For each of these specific problem areas a discussion is presented of the state of the art and of total information needs, the current and firm future plans of the safety program to obtain this information, and a recognition of information needed but not included in current planning, together with recommendations for obtaining the needed information. (auth)

22434 NUCLEAR SAFETY AND HEALTH PROTECTION IN POWER PLANTS AND FOR THE INDUSTRIAL USES OF RADIOISOTOPES: TECHNICAL-ADMINISTRATIVE ASPECTS. Williams, Ian G. K. (European Nuclear Energy Agency, Paris). pp 39-50 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The organization and objectives of the European Nuclear Energy Agency (E.N.E.A.) are described. Activities of the E.N.E.A. in the development of legal and technical standards of safety and health protection in the nuclear energy field are briefly discussed. (H.D.R.)

22435 ROLE AND FUNCTIONS OF EURATOM IN THE AREA OF HEALTH SAFETY IN NUCLEAR INSTALLATIONS. Recht, Pierre (EURATOM, Brussels). pp 51-63 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968). (In French).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22436 LICENSING AND REGULATION OF REACTORS IN THE USA. DiNunno, Joseph J. (Atomic Energy Commission, Paris). pp 65-86 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

The U.S. Atomic Energy Commission program governing the use of nuclear materials and nuclear facilities is described. Emphasis is placed on the regulatory program for licensing central station power reactors. The procedures involved in the process of obtaining a construction permit and an operating permit for U.S. reactors are discussed. (H.D.R.)

22437 RESPONSIBILITIES OF THE NATIONAL CENTER FOR RADIOLOGICAL HEALTH FOR REACTOR SITE SELECTION, ENVIRONMENTAL EVALUATION, AND PROTECTIVE ACTION PLANNING IN THE UNITED STATES. Terrill, J. G. Jr.; Weaver, C. L.; Harward, E. D.; Smith, J. M. pp 87-108 of Aspetti Tecnico-Procedurali della Sicurezza Nucleare e della Protezione Sanitaria per gli Impianti di Potenza e per gli Impieghi Industriali dei Radioisotopi. Roma; Comitato Nazionale Energia Nucleare (1968).

From 13th Nuclear Conference, Rome, Italy. See CONF-680330.

22438 SAFETY CONSIDERATIONS CONCERNING PEACEFUL USE OF NUCLEAR ENERGY. ANALYSES AND RESULTS. Schuster, G. (Bundesministerium fuer Bildung und Wissenschaft, Bonn). Atomwirt., Atomtech.; 15: 29-34(Jan 1970). (In German).

Arguments against and for peaceful uses of atomic energy are discussed. Among the fourteen points against nuclear energy the following are stressed: radiation danger to the population, thermal pollution of water, accidents during transport and storage of fissionable material, explosion of the plant through sabotage and enemy action in wartime, and illegal production of plutonium for nuclear weapons. Five points of positive considerations are stressed and explained, especially strict monitoring of installations, public education, complete public access to all governmental information, and communication with the population before site selection. (H.B.G.)

22439 PRESENT STATUS AND PROBLEMS ON SAFETY EVALUATION CODES FOR FAST REACTORS. Hirakawa, Naohiro; Saito, Shinzo (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 12: 124-34(1970). (In Japanese).

The present status on the safety evaluation codes for fast reactors is reviewed. The regions where more studies are called for to increase the reliability of these analyses are described. Anomalies occurring in reactor operation are analyzed under the headings of reactor stability, credible accidents, and hypothetical accidents. Under the first heading, a discussion is given on a model and codes to evaluate reactor stability including the bowing effect of fuel subassemblies, which might introduce a positive temperature coefficient. Under the second heading, a typical computational model and codes for credible accident analysis such as EXCURS and FORE II are described, and an account is given of efforts to develop codes that can deal more precisely with the space dependent effect. Under the third heading, a description is given of a method of analyzing an accident in which a fast reactor core melts and collapses. The usefulness of the modified Bethe–Tait analysis is discussed in this connection. Codes to treat phenomena that follow a nuclear burst (such as Na fire and fission product release) are briefly presented. A discussion is given on problems calling for further development to improve safety analyses. (45 references) (auth)

22440 NUCLEAR SAFETY. VOLUME 11, NUMBER 3. Cottrell, Wm. B.; Blakely, J. P.; Jordan, W. H.; Savolainen, A. W. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab. (May-Jun 1970). 99p. GPO $0.60.

Topics discussed relating to nuclear safety include: General Safety Considerations; Accident Analysis; Control and Instrumentation; Plant Safety Features; Operating Experiences; and Current Events. Separate abstracts are presented for 10 of the sections included. (D.C.C.)

For abstracts of individual papers see: 22373–22377, 22441–22443, 22463, and 22464.

22441 STUDIES OF FAST REACTOR CORE BEHAVIOR UNDER ACCIDENT CONDITIONS. Dickerman, C. E. (Argonne National Lab., Ill.). Nucl. Safety; 11: 195-205(May-Jun 1970).

Studies of fast reactor core behavior under accident conditions are included in the comprehensive USAEC safety program. Information is now becoming available on vaporization, pressure generation, and voiding of Na coolant under transient heating. Semiempirical models of oxide fuel failure are being developed from transient-experiment data. The complex relations between fuel failure, meltdown, and secondary movements of fuel and coolant are being studied in Na-filled capsules, autoclaves, and loops. Data now available indicate that, in some cases at least, the real behavior may be significantly less hazardous than predictions based on limiting-case models required in the absence of actual data. 95 references. (auth)

22442 RESEARCH ON THE USE OF CONTAINMENT-BUILDING SPRAY SYSTEMS IN PRESSURIZED-WATER REACTORS. Row, Thomas H. Nucl. Safety; 11: 223-34(May-Jun 1970).

Many of the pressurized-water reactors operating or under construction include containment-building pressure-reduction spray systems designed to incorporate a fission-product sequestering additive. A program to evaluate all aspects of the use of a spray system as an engineered safety feature has been coordinated by Oak Ridge National Laboratory for the AEC since March 1967. Current evaluations indicate that spray systems will rapidly remove molecular iodine and that methyl iodide and particulate removal are significantly slower processes. Radiolytic hydrogen generation by postaccident cooling of the reactor core introduces a significant design consideration. 19 references. (auth)

22443 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. (eds.). Nucl. Safety; 11: 244-60(May-Jun 1970).

Power Conversion Systems

22444 ROLE OF HIGH TEMPERATURE GAS TURBINES IN POWER GENERATION. Barnes, J. F. Combustion; 40: No. 3, 23-9(Sep 1968).

Some possibilities for achieving high gas temperatures in the turbines of both open-cycle and closed-cycle plants are analyzed. Experience gained from research, development, and design of internally cooled blading is reviewed. (7 references) (auth)

Research and Test Reactors

Refer also to abstracts 21035, 22101, 22239, 22376, 22377, 22386, 22390, 22428, 22429, 22431, 22436, 22440, 22443, 22491, 22503, and 22507.

22445 (AEEW-R-651) ELECTRONIC SYSTEM FOR PULSE RISE TIME DISCRIMINATION WITH A PROTON RECOIL PROPORTIONAL COUNTER. Taylor, J. R. (Atomic Energy Establishment, Winfrith (England)). Oct 1969. 29p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

An electronic pulse counting system in current use on the Zero Energy Fast Reactor ZEBRA for neutron spectra analysis from 3 keV to 1 MeV is described. The system uses a proton recoil proportional counter as detector and incorporates neutron-gamma separation by rise time discrimination. The collected data are stored in a Ferranti Argus 500 computer, for which a three-dimensional display is provided. (auth) (UK)

22446 (BNWL-1136) FAST REACTOR FUEL ASSEMBLY THERMAL HYDRAULIC DEVELOPMENT PROGRAM: SODIUM HEAT TRANSFER. Yatabe, J. M.; Collingham, R. E.; Hill, V. R.; McSweeney, T. I.; Thorne, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 82p. Dep. CFSTI.

The program plan for the out-of-reactor Na heat transfer testing required to support the design, safety evaluation and initial reactor operation of FFTF driver- and test-fuel assemblies is described. These tests will employ electrically heated models of FFTF fuel assemblies and will be conducted under conditions of flow and heat generation simulating FTR operating conditions. The program will provide directly applicable laboratory information to support evaluation of: clad temperatures and temperature gradients under normal and structurally distorted geometries; void initiation and propagation in loss of coolant accidents; emergency cooling operation and limits; postexpulsion cooling; and operational limits for driver and test fuels. (14 references) (auth)

22447 (IN-1350) FAST FLUX IRRADIATION FACILITY FOR THE ETR. Fast, E.; Russell, G. J. (Idaho Nuclear Corp., Idaho Falls). Mar 1970. Contract AT(10-1)-1230. 19p. Dep. CFSTI.

The results of a study initially intended to provide a basis for design and fabrication of an experimental facility are presented. The facility was to be used in the ETR to provide fast flux irradiation of various materials. However, before the study was complete, the direction of the experimental program had changed, and it is expected that initial fast flux irradiations will be done in EBR-II. This study has shown the feasibility of providing fast flux irradiation for experiments in ETR, and may be used in the future as a basis for further studies. (auth)

22448 (JAPFNR-7) OUTLINE OF THE JAPAN EXPERIMENTAL FAST REACTOR. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Translation of Japanese report. 24p. (PNC-N-141-69-14). Dep. CFSTI (U. S. Sales Only).

The background of the planning for construction of the Japan Experimental Fast Reactor (JEFR) is presented. The JEFR was designed to be a 100 MW(t) sodium-cooled fast breeder with PuO_2–UO_2 fuel. The site at Orari and the various reactor systems are described. (H.D.R.)

22449 (LFEN-NI.-43-a) DIFNE: FORTRAN PROGRAM LFEN-FR5, CALCULATION OF NEUTRON FLUX IN SUBCRITICAL ARRAYS. Salgado, Jose F.; Jorge, H. Machado (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 29p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

DIFNE is a program for calculating the neutron flux distribution in suboritical assemblies with cylindrical geometry. The program, based on two-group diffusion theory, calculates the fast and thermal flux in the axial, radial, and azimuthal directions. The fundamental theory and the program listing are presented. (H.D.R.)

22450 (MIT-4105-2) DESIGN, CONSTRUCTION, AND EVALUATION OF A FACILITY FOR THE SIMULATION OF FAST RE-

ACTOR BLANKETS. Forbes, I. A.; Driscoll, M. J.; Thompson, T. J.; Kaplan, I.; Lanning, D. D. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Feb 1970. Contract AT(30-1)-4105. 125p. (MITNE-110). Dep. CFSTI.

A facility has been designed and constructed at the MIT Reactor for the experimental investigation of typical LMFBR breeding blankets. A large converter assembly, consisting of a 20-cm-thick layer of graphite followed by a 17.5-cm-thick UO_2 fuel region, is used to convert thermal neutrons into fast neutrons to drive a blanket mockup. Operating at 55 watts, the converter generates blanket fluxes at an equivalent LMFBR core power of about 350 watts, with as little as one-tenth of the blanket material required for a critical assembly. Calculations show that the converter leakage spectrum is a close approximation to the core leakage spectrum from reference LMFBR designs, and that the axial distribution of the neutron flux in the blanket assembly simulates that in the radial blanket of a large LMFBR when the effective height and width of the blanket assembly are correctly chosen. Testing of the completed facility with a blanket composed of 50 v/o iron and 50 v/o borax showed that the lateral flux distributions were cosine-shaped, and that lateral spectral equilibrium was achieved in a large central volume of the blanket. Backscattering from concrete shielding surrounding the experiment was found to affect no more than the outer 30 cm of the blanket assembly, confirming the results of two-dimensional multigroup calculations. Measurements of the axial activity of gold and indium show good agreement with 16-group, S_8 ANISN calculations. (auth)

22451 NEUTRON FLUX IN THE IRRADIATION CHANNELS OF THE TRIGA MARK II REACTOR. Cingoli, F. (Univ., Pavia, Italy). Energ. Nucl. (Milan); 17: 196-7(Mar 1970). (In Italian).

The neutron flux at 250 kW was measured in the central channel, rabbit, rotating sample port, and thermal column of the University of Pavia Mark II Triga Reactor. Results are tabulated. (H.D.R.)

22452 INFLUENCE OF AN IRRADIATION DEVICE ON THE NEUTRON FLUX DENSITY AND THE REACTIVITY IN THE REACTOR. Daoud, H.; Franke, W.; Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH., Hamburg). Kerntechnik; 12: 24-9(Jan 1970). (In German and English).

The influence of an irradiation device (rig) in various in-core positions in the FRG reactor was studied in the course of zero-power experiments. Measured were the changes of reactivity and the effects of the rig on the distribution of the flux density of thermal, epithermal and fast neutrons. Comparison of the measured flux density distributions with the results of computations based on the diffusion theory and on the transport theory for the rig in the central position showed good agreement between the computed and the measured values. The ratio of the maximum to the mean flux density of thermal neutrons, which is one of the factors governing the maximum permissible power output, was determined for various arrangements of the rig in the core. (9 references) (auth)

22453 MEASUREMENTS OF K-INFINITY, REACTION RATES, AND SPECTRA IN ZEBRA PLUTONIUM LATTICES. Broomfield, A. M.; George, C. F.; Ingram, G.; Jakeman, D.; Sanders, J. E. (Atomic Energy Establishment, Winfrith, Eng.). pp 15-24 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

The design of Pu lattice experiments for providing integral data for the systematic adjustment of differential cross-sections is discussed. Target accuracies for measurements of k-infinity, reaction rates and spectra are specified. The experimental techniques currently in use for a series of zero-leakage Pu systems are described, together with new developments. Results for three lattices are presented and compared with theoretical predictions. (auth) (UK)

22454 ANALYSIS OF EXPERIMENTS PERFORMED IN MASURCA. Barberger, N. (Electricite de France, Aix en Provence); Humbert, G.; Storrer, F.; (and others). pp 25-37 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Experiments carried out in Masurca are mainly devoted to the study of the fundamental mode in fast media. In this study the material buckling B_m^2 is the most important parameter. Three main approaches were followed and are described: direct measurements of B_m^2 by means of axial and radial reaction rate traverses; a differential method which by progressive substitution gives the difference in B_m^2 compared to a reference medium; and a complementary method, using detailed analysis of balance through central reaction rate measurements. (auth) (UK)

22455 ARGONNE NATIONAL LABORATORY CRITICAL EXPERIMENT PROGRAM. Till, C. E.; Davey, W. G.; Lewis, R. A.; Palmer, R. G. (Argonne National Lab., Ill.). pp 40-9 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

The ANL critical facilities are described briefly, in the context of their capabilities and limitations. Certain major modifications to the facilities that reduce or remove some of these limitations are described. The directions of the current program are outlined, and the results from two recent series of basic physics assemblies of general interest are given in detail. The first is null-reactivity assemblies that give integral information on $^{239}\alpha$ in the kilovolt energy region, and the second is simple-composition Pu-fueled assemblies that give general information on plutonium cross sections. In each case the major experimental results are compared with analysis made using ENDF/B library data. The planned program of large Pu-fueled assemblies is then outlined briefly and as an example of the current status of one of the more important measurements made on assemblies of this kind, the measurements of the ^{238}U Doppler effect are selected for discussion in detail. The discussion first gives the results of measurements made to establish the measurement technique itself, and then focuses on the status of comparisons of the measurements with analyses made using ENDF/B data. (auth) (UK)

22456 STUDIES OF THE DOPPLER EFFECT, CONTROL ROD WORTHS, AND FISSION PRODUCT CROSS SECTIONS IN SOME FAST NEUTRON SPECTRA. Andersson, T. L.; Hellstrand, E.; Haeggblom, H.; Tiren, L. I. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 50-60 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Experiments at the fast critical assembly FRO are described. A comparison between calculated and experimental values of the activation Doppler effect in the ^{238}U (n,γ), ^{235}U (n,f) and ^{239}Pu (n,f) reactions in several cores including Pu loaded test zones is presented. The calculations underestimate the Doppler effect in ^{238}U by 20 to 30% in the temperature range 300 to 1800°K, while the variation of the fission cross section of ^{235}U and ^{239}Pu with temperature (300 to 1400°K) is grossly overpredicted. The reactivity worths of centrally located, fully inserted control rods are measured in several different FRO cores. The purpose of the experiment is to study to what extent the rod worth can be increased by introducing a hydrogeneous material in the hollow space inside a tubular rod. With natural or enriched boron as absorber a substantial increase in reactivity can be obtained. Results from some ^{235}U reaction rate measurements are included. An account of a first set of fission product cross section measurements at FRO is presented. Preliminary effective cross sections relative to a ^{235}U standard are determined in the soft spectrum FRO core 5. (auth) (UK)

22457 NEUTRON SPECTRUM MEASUREMENTS IN VARIOUS SUAK ASSEMBLIES. Bluhm, H.; Fieg, G.; Kappler, F.; Kuechle, M.; Mueller, M.; Werle, H.; Wattecamps, E. (Kernforschungszentrum, Karlsruhe, Ger.). pp 61-70 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

In the fast subcritical facility SUAK neutron spectra were measured from four uranium fueled systems. The first assembly consisted of 20% enriched uranium only, two cores contained hydrogen or carbon to shift the neutron spectrum, and the fourth core very closely simulated the VERA 7A core. In addition, the space dependence of the spectrum across an iron-sodium interface was studied. Measurements were made with proton recoil proportional counters, by the time-of-flight method, by resonance foil activation, and with a lithium sandwich spectrometer. The spectrometry methods are described and compared. An attempt is made to identify the confidence level of fast neutron spectrum measurements. (auth) (UK)

22458 FAST INTEGRAL EXPERIMENTS: WITH THERMAL DRIVER ZONE IN MINERVE; EXPONENTIAL EXPERIMENTS WITH HARMONIE; PULSED EXPERIMENTS IN COLLABORATION WITH THE GERMANS. Bouchard, J. (CEA, Cadarache, France. CEA, Fontenay-aux-Roses, France); Hammer, P.; Bramy, W.; (and others). pp 101-12 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

In addition to the Masurca experiments, systematic studies of fast systems are conducted in other facilities of the CEA. The experimental results obtained from fast-thermal critical, fast exponential experiments, and fast pulsed systems are reported. It is shown that they are consistent with the results yielded by critical assemblies. Comparison with calculated results are given, and problems arising in interpretation are mentioned. (auth) (UK)

22459 PHYSICS MEASUREMENTS IN THE SNEAK FACILITY ON STEAM-COOLED FAST REACTOR SYSTEMS WITH URANIUM AND PLUTONIUM FUEL. Edelmann, M.; Fischer, E. A.; Helm, F.; Schroeder, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp 113-35 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-69034.

The assemblies SNEAK-3A and B were uranium fueled assembly and an assembly in which a cylindrical central zone was fueled with plutonium. Steam coolant was simulated by polyethylene foils. Comparing measured and calculated data, it is noted that the agreement depends significantly on the composition of the core under investigation. A study was made as to how the information gained can be used to improve nuclear data sets. (auth) (UK)

22460 COMPARISON OF ANALYSIS OF FAST CRITICAL ASSEMBLIES USING SEVERAL CROSS SECTION DATA SETS AND DIFFERENT CROSS SECTION PROCESSING CODES. Fillmore, F. L.; Alter, H.; Otter, J. M.; Rose, P. F.; Dunford, C. L.; Hubner, R. S. (Atomics International, Canoga Park, Calif.). pp 141-8 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Results are presented for calculations of the eigenvalue, central fission ratios, and central reactivity coefficients for the ^{235}U fueled assembly ZPR-3-11, and for the ^{239}Pu fueled assemblies ZPR-3-48, 49, 50, and ZEBRA-6A. Three distinct sources of evaluated basic neutron cross-section data were used: ENDF/B data files, Atomics International data files (AIENDF), and the Karlsruhe data files (KEDAK). Comparisons for ZPR-3-48 and 11 are made between experimental results and calculations, using neutron cross sections taken exclusively from each of these data files. Using the ENDF/B data further comparison is made between results obtained with two independent systems of cross-section processing codes: the ETOE-MC^2 system and the AILMOE-GRISM system. In addition results obtained with updated AIENDF data for ZPR-3-48, 49, 50, and ZEBRA-6A are compared with experiments. It is found that none of the data sets tested adequately correlates the critical assemblies which were analyzed, and that more efficient methods for the economic generation of multigroup constants are required. (auth) (UK)

22461 STUDIES OF A MOCK-UP OF THE PROTOTYPE FAST REACTOR ON ZEBRA. Baker, A. R.; Collins, P. J. (Atomic Energy Establishment, Winfrith, Eng.). pp 213-21 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

A full-sized mock-up of the PFR was built as Assembly 7 on ZEBRA. Experimental results are given for k_{eff}, reaction rates, control rod worths, Na temperature coefficient and Doppler effect. These are compared with predictions based on U. K. methods and data (fine group library, FGL4, and 35-group set, FD4). The improvements in predictions of PFR performance that were made by these studies are identified. (auth) (UK)

22462 SOME INFORMATION GATHERED FROM RAPSODIE OPERATION. Chaumont, J. M. (CEA, Cadarache, France); Fournier, J.; Ladet, J.; Le Guillou, G.; Martin, J.; Strachura, S.; Stevens, L. pp 326-35 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Rapsodie first reached full power (20 MW(t)) in May 1967, and in December 1967 the power was uprated to 24 MW(t). In the progression to full power and thereafter the reactor behavior was analyzed, and the following two points are treated: the analysis of transfer functions, and the evolution of reactivity and of the power coefficient. (auth) (UK)

22463 RADON CONCENTRATION IN REACTOR CONTAINMENT BUILDINGS MASQUERADES AS ^{131}I RELEASE. Clack, R. W. (Kansas State Univ., Manhattan); Eckhoff, N. D. Nucl. Safety; 11: 235-7(May-Jun 1970).

The containment-building air at the Kansas State University TRIGA Mark II reactor became contaminated with radon, which presumably came from the thawing ground just outside the ventilation intake. Gamma-ray spectrum analysis identified the contamination as radon and its progeny instead of ^{131}I, with which it can be confused. A similar incident occurred in 1962 at the Union Carbide reactor in Sterling Forest, N. Y. 8 references. (auth)

22464 A COMPARISON OF TWO ^{16}N RADIATION SUPPRESSION DEVICES FOR TWO TYPES OF RESEARCH-REACTOR FUEL. Cashwell, R. J. (Univ. of Wisconsin, Madison). Nucl. Safety; 11: 237-40(May-Jun 1970).

Personnel at the University of Wisconsin nuclear reactor have made detailed radiation measurements for comparing the efficiency of a Plexiglas plate-type ^{16}N diffuser with an 80 gal/min jet-type diffuser. Although much less effective than the jet-type diffuser, the plate-type diffuser offers greater simplicity and reliability with no reactivity disturbances. (auth)

Rocket and Space Reactors

Refer also to abstracts 20938 and 21410.

22465 (RN-TM-592) AN EXPERIMENTAL STUDY OF THE NOISE FIELD RESULTING FROM GROUND TESTING A NUCLEAR ROCKET ENGINE. NERVA Program. Fairall, R. S.; Thompson, W. R. (Aerojet-General Corp., Sacramento, Calif.). 20 Oct 1969. Contract SNP-1. 59p. Dep. CFSTI.

The experimental engine cold flow (XECF) tests were conducted in April 1968 in Engine Test Stand No. 1 (ETS-1) at the Nuclear Rocket Development Station (NRDS) in Nevada. Posttest inspection of ETS-1 showed evidence of damage that was caused by acoustic forces. Because the duct effluent from XECF tests had relatively low kinetic energy, it was apparent that the jet noise anticipated during later high-power engine tests could reach destructive levels. To determine the magnitude and extent of the noise field resulting from ground tests of the rocket engine, a comprehensive investigation to identify the factors necessary to define the acoustics was conducted. The investigation was divided into four steps: (1) analytical predictions of the acoustic environment, (2) scale-model tests to clarify the empirical factors required for analysis, (3) improvement of the facility components as required, and (4) acoustic measurements of the sound pressures during power tests (up to and including the full-power test and comparison of measured data with predictions). The fourth step is described in detail and the entire investigation is summarized. The experimental information, theoretical results, and full-scale test data are presented. (auth)

22466 PERFORMANCE PARAMETERS FOR NUCLEAR ROCKETS. d'Elia, Giovanni (Univ., Naples). Ing. Nucl.; 10: No. 4, 10-22(Jul-Aug 1969). (In Italian).

A solid core nuclear reactor as an engine for rockets presents operating limitations in regard to structural integrity. These limitations are discussed, and their effects on the reactor are examined in terms of performance indices. A solid core rocket reactor is described and its basic operating parameters are discussed. Factors limiting the efficiency of rocket reactors are also examined. (H.D.R.)

Process Heat and Desalination Reactors

22467 (BMwF-FBK-69-40) ECONOMIC COMPARISON OF SEA WATER DESALINATION PLANTS IN COMBINATION WITH VARIOUS TYPES OF NUCLEAR REACTORS. Baranowski, K.; Lukacs, G.; Rossberg, K.-E. (Fried-Krupp G.m.b.H., Industriebau und Maschinenfabriken, Essen (West Germany)). Nov 1969. 97p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED DM 20.20.

Seawater desalination plants in conjunction with the different nuclear reactors which are built or planned in the Federal Republic have been investigated and compared with each other. The coupling in a dual purpose system has been based on the back pressure scheme and the desalting unit on the principle of multistage flash distillation. For the demand of fresh water and electricity which has been ascertained in a market analysis of several regions, dual purpose plants coupled to water reactors offer the lowest cost. High temperature reactors delivering energy for de-

salination plants are especially suitable as energy centers for large consumer groups. 29 references. (auth)

22468 PROCEEDINGS OF WESTERN WATER AND POWER SYMPOSIUM, APRIL 8–9, 1968, LOS ANGELES, CALIFORNIA. Los Angeles; Institute of Electrical and Electronics Engineers (1968). 669p. $20.00. (CONF-680409). Western Periodicals Co., North Hollywood, Calif.

Topics discussed which relate to water conservation and electric power generation include: conveyances and hydraulic disturbances; hydraulic equipment and fluid mechanics; desalination; and extra high voltage and power generation. A separate abstract is included for one of the 46 papers presented. (D.C.C.)

For an abstract of one paper see: 22469.

22469 BOLSA ISLAND NUCLEAR POWER AND DESALTING PLANT. INITIAL STUDIES AND STATUS. Goodell, J. H.; Wilson, W. H. (Bechtel Corp., Los Angeles). pp C.11-19 of Proceedings of Western Water and Power Symposium, April 8–9, 1968, Los Angeles, California. Los Angeles; Institute of Electrical and Electronics Engineers (1968).

The development of the concept for the world's largest nuclear powered dual-purpose desalting and electric power plant is described. The studies initiated in 1965 to the present are reviewed. (auth)

22470 DESALTING: STATE OF THE ART. Bulletin No. 134-69. Sacramento, Calif.; Department of Water Resources (1969). 63p. $1.00. Office of Procurement, Documents Section, Sacramento, Calif.

The world-wide capacity of desalting plants by the end of 1967 was about 220 million gallons per day. Construction was started on 45 plants in 1967. Most seawater desalting plants continue to employ the distillation process, while brackish water plants utilized membranes. When large-capacity desalters are built, it is expected that the thermal distillation process, such as the multistage flash process, will be used. It is expected the large-capacity plants will use nuclear energy for steam generators. The steam will be used for the dual-purpose of power generation and water desalting. Desalting costs are expected to be reduced substantially over the next 20 years. Such expectations are based on anticipated technological improvements in desalting processes and nuclear energy producers. The estimated cost of desalting water from large-capacity dual-purpose facilities, based on current estimates as indicated by the Bolsa Island Project, is $120 per acre-foot at the site. This estimate includes escalation to the completion of construction of the project, assumed to be 1974 to 1978. (auth)

22471 OPTIMIZATION OF BASIC PARAMETERS OF THERMAL DESALTING PLANTS WITH ADIABATIC EVAPORATION. Korneichev, A. I.; Izvekov, A. V.; Myagkov, A. A. (Government Committee on the Utilization of Nuclear Energy, Moscow). Desalination; 7: 179-86(Feb 1970).

A method is presented for complex optimization of the parameters of desalination plants with adiabatic evaporation. The computation of optimal parameters of single- as well as dual-purpose desalination plants by the proposed method is not complicated. The computational program of the optimal parameters is easily carried out on electronic computers. (auth)

Marine and Portable Power Reactors

22472 (AD-699316) CORE MANAGEMENT PLAN FOR THE MH-1A. Final Report. Iyer, Shrinivas S.; Saunders, Ralph S. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). 3 Oct 1969. 29p. (ED-6920). CFSTI.

The fuel cycle costs of the MH-1A for two core management plans are analyzed. The calculated cost figures are based on the most current data. Each plan includes the core refueling and cost schedules over the life of the plant. The cost schedules are intended to serve as support data for determining funding requirements. Finally, comparison is made of the two plans with regard to total cost, cost per fiscal year, and cost per kilowatt-hour of electrical energy produced. (auth) (USGRDR)

22473 (AD-699317) SM-1A VAPOR CONTAINER LEAK TEST: APRIL 3–8, 1969. Final Report. Gould, Chauncey L. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). 20 Oct 1969. 32p. (ED-6921). CFSTI.

22474 (AD-699330) SM-1A PRESSURE VESSEL LIFETIME AS RESULT OF IN-PLACE ANNEALING. Final Report. Knighton, George W. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). 19 Sep 1969. 75p. (ED-6922). CFSTI.

The "recovery of ductility" of the SM-1A reactor vessel steel as a result of the "in-place" annealing is described. The pre-annealing vessel lifetime, the general annealing techniques used, the surveillance specimen program to evaluate the recovery, the recovery accomplished, and the estimated lifetime of the annealed reactor vessel are discussed. (auth) (USGRDR)

22475 (DOCKET-50238-58) N. S. SAVANNAH. Operator Retraining Program. (First Atomic Ship Transport, Inc., New York). 31 Mar 1970. 4p. Dep. CFSTI.

22476 (HIT-3775-1(Add.)) ADDENDUM TO PM-3A HAZARDS ANALYSIS REPORT, TYPE 4 CORE. (Hittman Associates, Inc., Columbia, Md.). Feb 1970. Contract AT(30-1)-3775. 63p. (HIT-340(Add.)). Dep. CFSTI.

The safety of operation of the PM-3A Type 4 Core has been analyzed for various potential nuclear accidents and secondary system transients. Also, the fission product inventory has been accurately determined at the end of life. In all analyses, the nuclear parameters have been determined based on the PM Type 4 Core design reports and technical manuals for the PM-3A plant. (13 references) (auth)

22477 (HIT-3775-1(App.)) APPENDICES TO ADDENDUM TO PM-3A HAZARDS ANALYSIS REPORT, TYPE 4 CORE. (Hittman Associates, Inc., Columbia, Md.). Feb 1970. Contract AT-(30-1)-3775. 75p. (HIT-340(App.)). Dep. CFSTI.

Appendices presented discuss the following topics: Fission Product Inventory; Analog Equations; Analog Constants and Initial Conditions; Fuel Pellet Temperature Distribution Model; Pressure Calculations; Velocity Analysis; and Analysis of Nuclear Effects in Refueling Accident. (D.C.C.)

Production Reactors

22478 (DPSPU-69-30-10) REACTIVITY EFFECTS OF ^{135}Xe AND ^{149}Sm IN MIXED LATTICES AFTER SHUTDOWN. Benton, F. D.; Enzbrenner, F. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sep 1969. Contract AT-(07-2)-1. 9p. (CONF-691009-7). Dep. CFSTI.

From Conference on Reactor Operating Experience, San Juan, Puerto Rico.

The effect of the principal fission products, ^{135}Xe and ^{149}Sm, on production reactor operation is analyzed. The method by which the reactivity effects of the fission products are calculated is presented. (5 references) (auth)

22479 (DPSPU-69-30-18) OPERATING PHILOSOPHY AFTER 12 REACTOR-YEARS EXPERIENCE WITH ON-LINE COMPUTERS. Gimmy, K. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). [1969]. Contract AT(07-2)-1. 12p. (CONF-691009-8). Dep. CFSTI.

From Conference on Reactor Operating Experience, San Juan, Puerto Rico.

The Savannah River Plant (SRP) is a U. S. Atomic Energy Commission production facility. Three large reactors are each equipped with an on-line digital computer that has 3450 analog inputs and is used by the operating group 24 hours per day. Thus SRP's interest in reliability and operator acceptance closely parallels that of a power reactor. There is also an aggressive technical program that results in new applications for the computers. The guidelines that have been evolved for four types of computer-reactor applications are summarized. Three problem areas and some suggested solutions are described. (auth)

22480 (DUN-SA-116) ACTIVATED CHARCOAL FILTER HISTORY OF THE HANFORD SINGLE PASS PRODUCTION REACTORS FROM MARCH 1968 TO THE PRESENT TIME. Mecca, J. E. (Douglas United Nuclear, Inc., Richland, Wash.). Oct 1969. Contract AT(45-1)-1857. 35p. (CONF-691009-6). Dep. CFSTI.

From Conference on Reactor Operating Experience, San Juan, Puerto Rico.

During the replacement of some damaged particulate filters at Hanford C Reactor, a visual inspection revealed damaged charcoal filter units. Several of these filters were removed and tested for absorption efficiency. These test results led to an inspection of all installed charcoal filters at the C, KE, and KW reactors and a decision to renovate all charcoal filters at these reactors. The Hanford reactors confinement systems are described, and the field inspections, laboratory filter tests, and laboratory absorption efficiency tests on charcoal samples are discussed. (H.D.R.)

Reactor Theory

Refer also to abstract 20743.

Kinetics

Refer also to abstracts 22386 and 22393.

22481 (EURFNR-697) CALCULATION OF DOPPLER COEFFICIENTS FOR FAST REACTORS. Siep, Irmgard (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-983. 66p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A complete documentation of the theoretical background of the Karlsruhe Doppler-Coefficient (DC)-Program is presented. The theory has been changed in some aspects compared to the formalism given in the original description by Froelich (KFK 367). At various points of the derivation of the formulas generalizations of the theory are proposed. Results of the DC-Program are compared with Doppler-coefficients calculated by other methods available within the NUSYS-System: successive-K-calculation and perturbation theory. The different results are discussed. (auth)

22482 FAST METHODS FOR COMPUTING THERMAL-NEUTRON GROUP CONSTANTS IN SINGLE-PIN LATTICE CELLS. Stammler, Rudolf J. J. (Aktiebolaget ASEA-ATOM, Vasteras, Sweden). ASEA (Allm. Sv. Elek. A. B.) Res.; 10: 7-62(1969).

Rapid computational methods for producing thermal-neutron group constants in uniform single-pin lattices moderated by water and/or heavy water were developed and tested. These constants enable homogenization of the lattice cell with respect to the thermal-neutron distributior, as they provide sufficient information to describe its thermal reaction rates. Two examples of such fast codes are given: DATAPREP-II and SATAN. They are fast enough to be incorporated in calculational schemes for fuel-cycle studies and reactor design. The former replaces the thermalization range with a single energy group, thereby reducing the problem to a one-group calculation of flux ratios using effective cross-sections. The latter calculates flux ratios for a number of energy groups and homogenizes the cell by flux and volume averaging of the cross-sections per group. The fast codes were tested against the results of the sophisticated code K-7 THERMOS, which evaluates the thermal-neutron distribution in space and energy in a circularized cell under the assumption of isotropic scattering in the laboratory system. With this code, the various approximations that were used are discussed and found to be satisfactory. However, the final check on the reliability of K-7 THERMOS as a standard for testing the fast codes should be made by a comparison of its results with measurements. Such a comparison has been carried out on a number of uniform uranium lattices at room temperature. Good agreement was observed in those cases where the experimental data were carefully analyzed and the perturbing effects of the measuring device eliminated. SATAN appeared to be in good agreement with K-7 THERMOS, while neglecting the spatial variation of the spectrum in the lattice cell turned out to be a serious drawback for DATAPREP-II. (auth) (Sweden)

22483 COMPARISON OF SYNTHETIC KERNEL TRANSPORT RESULTS. Natelson, M. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 40: 153(Apr 1970).

A synthetic kernel transport approximation is compared with P_1 and D_{16} results and with an SP_3 approximation for a fixed source problem representing the fast group of a four-group pressurized water reactor cell. (3 references) (H.D.R.)

22484 QUALITATIVE EVALUATION OF FAST REACTOR MELT-DOWN ACCIDENTS. Komata, Masaoki (Hitachi Ltd., Kawasaki, Japan). Nucl. Sci. Eng.; 40: 150-2(Apr 1970).

The energy release during meltdown accidents is formulated, and its dependence on neutron lifetime, inserted reactivity, Doppler coefficient, and other material constants is determined. Two cases are considered: the first includes only the Doppler effect as a feedback mechanism; and the second includes the disassembly effect alone. (12 references) (H.D.R.)

22485 REACTIVITY CHANGES DUE TO THE RANDOM VIBRATION OF CONTROL RODS AND FUEL ELEMENTS. Williams, M. M. R. (Univ. of London). Nucl. Sci. Eng.; 40: 144-50(Apr 1970).

The effect of random vibration on the average power density is examined. Situations in which perturbation theory analysis of noise sources is not valid are considered. In such situations the equation for the average power will be characterized by the nature of the random process and will affect the criticality condition and the flux distribution. Three problems are considered: (1) a single absorbing plate, randomly vibrating in an infinite medium; (2) a plane lattice of fuel elements in random vibration; (3) a single point absorber, randomly vibrating in a finite medium. (5 references) (H.D.R.)

22486 ON THE EFFECT OF DELAYED NEUTRONS IN REACTOR EXCURSIONS WITH RAMP REACTIVITY INSERTION. Hetrick, David L. (Univ. of Arizona, Tucson); Canosa, Jose. Nucl. Sci. Eng.; 40: 141(Apr 1970).

A derivation of the ratio of the power at prompt criticality to the initial power at delayed criticality in a fast ramp with delayed neutrons is presented. It is based on results obtained for the ramp problem when nonlinear temperature feedback and delayed neutrons are considered. (4 references) (H.D.R.)

22487 PULSE CHARACTERISTICS FOR RAMP REACTIVITY INSERTION AND ENERGY-SHUTDOWN REACTOR EXCURSIONS. Redmond, R. F. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. Nucl. Sci. Eng.; 40: 141-4(Apr 1970).

Estimates of reactor rapid excursion characteristics can be obtained with a model due to Fuchs based upon the assumptions of a ramp insertion of reactivity and negative energy-feedback. The kinetics equation for this model is solved numerically and generalized numerical results are presented. (H.D.R.)

22488 GENERAL MULTIGROUP AND SPECTRAL SYNTHESIS EQUATIONS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 40: 73-90(Apr 1970).

The multigroup neutron kinetics equations are derived and investigated for the case when the within-group weighting spectra, which are used in defining group constants, are space- and time-dependent. New terms are introduced by the space- and time-dependence of these weighting spectra. The derivation is carried through the hierarchy of operations by which the continuous space, time, and lethargy dependence is replaced by a discrete representation. The new terms do not alter the usual positivity properties associated with the discrete multigroup kinetics equations, provided that certain conditions are satisfied. Conditions are also established which are sufficient to ensure that the discrete representation is adjoint consistent; i.e., the discrete representation of the adjoint equation is mathematically adjoint to the discrete representation of the direct equation. A similar development is presented for the Spectral Synthesis approximation. Conditions are established for the adjoint consistency of the discrete representation. The type of positivity argument made for the multigroup equations is shown to be invalid for the Spectral Synthesis equations. (6 references) (auth)

22489 HETEROGENEITY EFFECTS ON NEUTRON SELF-SHIELDING FACTORS FOR FAST REACTORS. Bitelli, G.; Salvatores, M.; Cecchini, G. (Comitato Nazionale per l'Energia Nucleare, Rome). Nucl. Sci. Eng.; 40: 138-40(Apr 1970).

The importance of accounting for the effects of lattice heterogeneity on the resonances in the interpretation of integral measurements in fast reactors is examined. A method for analyzing heterogeneous lattices based on the method of Abajan, Bazazjantz, Bondarenko, and Nikolaev is presented. (10 references) (H.D.R.)

22490 BUCKLING CORRECTION FOR EXPERIMENTAL POWER DISTRIBUTION WITHIN FUEL ASSEMBLIES IN A FINITE SYSTEM. Kobayashi, Iwao; Matsuura, Shojiro (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 7: 145-52(Mar 1970).

For design calculations to determine the local power distribution in a fuel assembly of a power reactor, the neutron flux is usually assumed to be symmetrical at the outer boundary of the assembly. In actuality, experimental data on power distributions are obtained in a finite system where this symmetry does not apply, so that the calculated values cannot be directly compared with observed data. In a zero power critical experiment in particular, the measurement must be performed in a fairly small core assembly to economize the amount of fuel materials to be used for simulation. This introduces the necessity of special considerations in the comparison between design and observed data. A method incorporating direct corrections to the experimentally determined power distributions based on the geometrical buckling of the system is proposed. In this method the experimental power $P_0(r)$ is divided by the neutron flux $Q(r)$ which is determined in the critical state with geometrical buckling in a bare (one neutron energy group) reactor, neglecting the reflector region of the experimental system. A sample application of the method to an actual light water lattice confirmed the validity of the method. (4 references) (auth)

22491 OPTIMIZATION OF NEUTRON CROSS-SECTION DATA ADJUSTMENTS TO GIVE AGREEMENT WITH SPECTRUM MEA-

SUREMENTS AT THE CENTRE OF CRITICAL SYSTEMS. Ballance, B. M. O.; Pendlebury, E. D.; Price, J. A.; West, P. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 149-56 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

The spectra at the center of critical and near-critical systems are currently being measured at AWRE. A method by which these measurements can be systematically exploited to improve neutron cross section data is briefly described, along with the computer programs which have been written to implement it. The feasibility of the method is demonstrated by the results of trial calculations. (auth) (UK)

22492 NEW MULTINODE FOR THE ANALYSIS OF SPACE DEPENDENT FAST REACTOR KINETICS. Dyos, M. W.; Hansen, K. F.; Hauger, S. E. (Westinghouse Electric Corp., Madison, Pa.). pp 283-5 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

An approximate method was developed for analyzing space dependent reactor kinetics in a fast reactor. The method has the advantage that the amount of computer time required for solution is only weakly dependent on the number of dimensions being considered. (auth) (UK)

22493 SPACE–TIME BEHAVIOR OF LARGE POWER REACTORS CONSEQUENT TO LOCALIZED ACCIDENTS. Cecchini, G. (CNEN, Rome); Galligani, I. pp 286-9 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

An analysis is made of numerical methods for space-time calculation of nuclear reactors. The Kantorovich method and the reduced Euler method are compared for significant cases relevant to localized accidents in fast reactors. The results show the need of adopting the Euler method if an adequate description of the flux transients is required. (auth) (UK)

Experimental Applications

Refer also to abstracts 22387–22389, 22405, 22458, and 22460.

22494 (ANL-Trans-820) AUTOMATION OF THE MEASUREMENT OF REACTIVITY. Voronin, A. A.; Ostapenko, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Argonne National Lab., Ill., from report IAE-1689. 18p. Dep. CFSTI.

A general comparative evaluation of the possibilities of the automatic measurement of reactivity is discussed from the point of view of experimental possibilities, expenditure of time, and safety. The analytical description of the method is based on the statements of the theory of invariance and utilizes the device of symbolic transfer functions and differential equations. The main results of the investigation are related to building a semiconductor reactivity meter of the type PIR-2 and its experimental utilization in the MR and IRT-M research reactors at the I. V. Kurchatov Atomic Energy Institute. (auth)

22495 (CTH-RF-18) MEASUREMENT OF THE NEUTRONIC INTERACTION BETWEEN TWO CYLINDRICAL MODERATORS. Grosshoeg, Gudmar (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Reaktorfysik). Nov 1969. 29p. Dep. CFSTI (U. S. Sales Only).

The stationary interaction parameter between the plane surfaces of two identical, cylindrical, polyethylene discs were measured with the pulsed neutron method. It was shown possible to overcome the delay effect caused by the flight of the neutrons in the gap between the moderators by means of the insertion of absorbers. In the measurements the ratio of separation distance to diameter was varied between 0.06 and 0.77 and the corresponding interaction parameter went from 0.93 to 0.24. Using two different thicknesses of the discs two series of measurements were performed, one covering decay constants between 10,000 and 17,000 s^{-1} and the other range 17,000 to 40,000 s^{-1}. Although full equilibrium of the neutron distribution was not reached in all cases in the last series, the resulting values of the two series show a general agreement. A calculation based on a zeroth order Bessel function as radial distribution and $(\cos\theta)/\pi$ as angular distribution of the neutrons leaving the interacting surfaces gives too large interaction parameter for all separation distances. However, the overestimate seems to be small when the surfaces are close together. 14 references. (auth) (Sweden)

22496 (EURFNR-739) PYGMY: A ZERO-DIMENSIONAL BURN-UP PROGRAM FOR FAST REACTORS. Mayer, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct 1969. 28p. (KFK-1056; EUR-4313). Dep. CFSTI (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

PYGMY is a refined and extended version of the zero-dimensional burn-up code PYRE, which calculates the changes of reactivity, neutron spectrum, and isotopic concentrations with time, taking into account management operations and allowing for a very general isotopic scheme. The code is written in Fortran IV for the IBM 360. An input description and a sample case are presented. Results of a calculation of the transplutonium build-up, including the berkelium and californium isotopes, in thermal fluxes of 5×10^{13} to 3×10^{16} cm^{-2} sec^{-1} are presented. 4 references. (auth)

22497 (LA-4342) DAC1: A ONE-DIMENSIONAL S_n PERTURBATION CODE. Carmichael, B. M. (Los Alamos Scientific Lab., N. Mex.). 1 Dec 1969. Contract W-7405-eng-36. 8p. Dep. CFSTI.

DAC1 uses fluxes from the DTF S_n code to calculate reactivity perturbations, effective delayed neutron fractions, and generation times in reactors. The FORTRAN-IV programming techniques and input format of DTF are retained in DAC1. The reference reactor specifications are input to DAC1 by a direct reading of the DTF input deck; consequently, the only additional input needed is the perturbation specifications. 3 references. (auth)

22498 APPLICATION OF SPECTRAL ANALYSIS TO EXPERIMENTAL RESEARCH IN THE VIBRATIONS FIELD. Cedolin, L.; Hassid, A.; Rossini, T. (CISE, Milan). Energ. Nucl. (Milan); 17: 164-75(Mar 1970). (In Italian).

A brief description of the application of spectral analysis to experimental research in the field of vibrations, is given. The utilization of some computational programs for the on line estimation of auto and cross spectra for the analysis of vibrations induced by two-phase (steam-water) flow on the fuel elements under development for the CIRENE reator is described. 8 references. (auth)

22499 EVALUATION OF NEUTRON SPECTRAL EFFECTS IN SYSTEMS WITH THERMAL RESONANCE ABSORBERS BY APPLYING A CORRELATION METHOD TO MEASURED SPECTRAL INDEXES. Gibello, A.; Orestano, F. V.; Pistella, F.; Santandrea, E. (Comitato Nazionale per l'Energia Nucleare, Rome). Nucl. Sci. Eng.; 40: 51-72(Apr 1970).

Spectral indexes were measured in homogeneous systems (solutions of europium and boron). The measured values were compared with the results of spectra calculations and, independently, were utilized for a correlation method devised to deduce the reaction rates which are undetectable directly. The reliability of the THERMOS code for spectra calculations in such systems was shown. A satisfactory test of the correlation method was performed. The adequacy of the cross-section sets available in the literature was shown for the detectors ^{197}Au, ^{63}Cu, ^{55}Mn, ^{176}Lu, ^{239}Pu, and ^{235}U. The sets available for ^{151}Eu and ^{175}Lu are not satisfactory: new evaluations were carried out by properly utilizing measurements reported in the literature and/or new measurements performed for this purpose in a known spectrum. When using the new sets, the agreement between calculated and experimental spectral indexes in the absorber solutions is significantly improved. When reliable cross sections are available for the detectors, the correlation method can be considered a powerful tool for the evaluation of an unknown reaction rate: for instance the ^{239}Pu absorption rate in the solutions is evaluated by means of the measured activation rates without introducing uncertainties due to the correlation procedure itself. (30 references) (auth)

22500 A COMPARISON OF THERMAL-NEUTRON-ACTIVATION MEASUREMENTS AND MONTE CARLO CALCULATIONS IN LIGHT-WATER-MODERATED URANIUM CELLS. Volpe, J. J.; Hardy, J. Jr.; Klein, D. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 40: 116-27(Apr 1970).

Thermal disadvantage factors and spectral indexes were measured in a variety of light-water-moderated lattices. One series contained slightly enriched U rods in hexagonal geometry and another series used natural-U fuel in slab geometry. The detectors used were ^{164}Dy, ^{176}Lu, and ^{239}Pu. Full energy range (0 to 10 MeV) Monte Carlo calculations with explicit cell-geometry representations were performed using the RECAP program. In addition, thermal energy range (0 to 0.625 eV) calculations were obtained with the Monte Carlo program MARC as well as with the integral transport-theory-code THERMOS. The purpose of these investi-

gations was to test the adequacy of the various water scattering kernels—Nelkin, Koppel, and Haywood—for a broad range of thermal-flux characteristics: from a soft moderator spectrum with a steep spatial gradient to a very hard spectrum which was relatively flat as a function of position. The conclusions obtained were as follows. Calculated spectral indexes using the Haywood kernel were 2 to 3% higher than experiment, on the average, in the fuel region of these cells. Use of the Koppel kernel removed most of this disagreement in the case of ^{176}Lu but the comparison for ^{239}Pu remained unchanged. On the basis of these results, the thermal-flux spectrum obtained with the Haywood model appears to be slightly too hard. With regard to the disadvantage factors, good agreement was generally obtained between theory and measurement except for the tightest lattices. The calculated disadvantage factors were found to be insensitive to the kernel model selected. The effects from including thermal-scattering-pattern treatments above P_1 as well as a spatially dependent and anisotropic source-to-thermal description were found to be small in these cells, <2%. (19 references) (auth)

22501 A STUDY OF PHYSICS PARAMETERS IN SEVERAL H_2O-MODERATED LATTICES OF SLIGHTLY ENRICHED AND NATURAL URANIUM. Hardy, J. Jr.; Klein, D.; Volpe, J. J. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 40: 101-15(Apr 1970).

The full-range Monte Carlo program RECAP was used in a consistent analysis of parameters measured in seven H_2O-moderated U lattices: four were lattices of slightly enriched rods and three were natural-U-slab lattices. The most important parameters were: epithermal-to-thermal ratios for ^{238}U capture (ρ^{28}) and for ^{235}U fission (δ^{25}), ratio of ^{238}U fission-to-^{235}U fission (δ^{28}), eigenvalue, integral fast/epithermal spectrum comparisons with a variety of detectors, and resonance integrals for isolated U and UO_2 rods (calculated with the Monte Carlo program RESQ, supplemented by ZUT and TUZ at higher energies). The analysis of these lattices was fairly unambiguous and served to test the input nuclear data for ^{238}U, ^{235}U, and H_2O. With one exception, leakage was small (<20%) and parameters were measured in nearly asymptotic flux spectra. These covered a wide range of hardness as reflected in the change of parameters: ρ^{28} ranged from 0.5 to 12; δ^{25} from 0.04 to 1.1; and δ^{28} from 0.05 to 0.44. The Monte Carlo cell calculations were corrected for leakage by means of the homogenized lattice programs P3MG and MUFT-MAGMA. With a straightforward choice of current "best" nuclear data, the calculations reproduce virtually all the parameters over the whole range of lattices. There are two qualifications: some reduction of smooth ^{238}U capture integral is required to match the lattice measurements (by an amount barely compatible with the isolated rod measurements), and there is too much calculated epithermal ^{235}U fission in the very tight lattices. (35 references) (auth)

22502 NULL-REACTIVITY MEASUREMENTS OF CAPTURE/FISSION RATIO IN ^{235}U AND ^{239}Pu. Till, C. E.; Gasidlo, J. M.; Groh, E. F.; LeSage, L. G.; Robinson, W. R.; Stanford, G. S. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 40: 132-6(Apr 1970).

Integral measurements of the capture to fission ratio were made in fast critical assemblies containing large null-reactivity zones made up of Pu or ^{235}U fuel, depleted U, graphite, and structural stainless steel. The measured results are compared to calculations made using ENDF/B data. (12 references) (H.D.R.)

22503 REACTOR POWER MEASUREMENTS FROM XENON POISIONING. Rada, G.; Coello, E.; Ollarves, H. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Acta Cient. Venez.; 20: No. 1-2, 28-30(1969). (In Spanish).

Several methods for the calculation of the operating power of a nuclear reactor from the evolution of xenon poisoning are discussed. These methods have been applied to several operating runs at RV-1 swimming pool reactor with satisfactory results. (6 references) (auth)

22504 FAST REACTOR DATA, CODES, AND INTEGRAL EXPERIMENTS. Chernick, J.; Price, G.; Levine, M. M. (Brookhaven National Lab., Upton, N. Y.). pp 77-81 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Recent experience at Brookhaven in the development of fast reactor codes and the use of evaluated nuclear data in these codes is discussed. Comparison with integral experiments indicates that the current ENDF/B library and its associated programs and reactor codes are generally sound and will be very useful when the current round of checks against integral experiments is completed. Results of the BNL experiments on Pu-Al rod poisoned heavy water lattice experiments are detailed. (auth) (UK)

22505 UTILIZATION OF GENERALIZED PERTURBATION TECHNIQUES AND OF A COLLISION METHOD FOR LOCALIZED EXPERIMENTS IN FAST FACILITIES. Bitelli, G.; Salvatores, M. (CNEN, Rome). pp 90-2 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

A collision technique is derived which gives the first, second, etc., collision densities starting from a real or adjoint sources. A significant application relevant to the evaluation of localized integral experiments using generalized perturbation methods is shown. (auth) (UK)

22506 EVALUATION OF FAST CRITICAL EXPERIMENTS BY USE OF RECENT METHODS AND DATA. Kiefhaber, E.; Kuesters, H.; Schmidt, J. J.; Bachmann, H.; Krieg, B.; Stein, E.; Thiem, D.; Wagner, K.; Hinkelmann, B.; Siep, I. (Kernforschungszentrum, Karlsruhe, Ger.). pp 94-100 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

The analysis of a series of fast critical experiments, with the latest information on basic nuclear data, was performed in the attempt to find reasons for the known deviations between theoretical prediction and experimental result. First, the theoretical methods used and the errors due to certain approximations (transport effects, multigroup scheme) are discussed. From the various data uncertainties those of the cross sections of heavy isotopes were investigated with main priority $\sigma_c(^{238}U)$, $\sigma_f(^{235}U)$, $\sigma_c(^{235}U)$, $\sigma_f(^{239}Pu)$, $\sigma_c(^{239}Pu)$. In inelastic scattering the effect of the replacement on ABN probabilities by Karlsruhe data is considered. The results of this investigation will hopefully allow judging to a higher degree of confidence the accuracy of the predicted physical properties of large fast power reactors. (auth) (UK)

22507 LESSONS DRAWN FROM INTEGRAL EXPERIMENTS ON A SET OF MULTIGROUP CROSS SECTIONS. Barre, J. Y.; Heindler, M.; Lacapelle, T.; Ravier, J. (CEA, Cadarache, France). pp 165-79 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

Two methods of using integral experiments to improve the basic neutron data of a nultigroup cross section set are described. First a statistical analysis of a large number of integral parameters measured in fast critical assemblies indicate modifications in cross sections for ^{235}U, ^{238}U, ^{239}Pu and Fe, leading to a new cross section set. Secondly, the utility of specific critical experiments for basic neutron data is demonstrated for the capture cross section of Ni and high energy cross sections of fissile isotopes. (auth) (UK)

22508 USE OF INTEGRAL MEASUREMENTS TO ADJUST CROSS-SECTIONS AND PREDICT REACTOR PROPERTIES. Rowlands, J. L.; Macdougall, J. D. (Atomic Energy Establishment, Winfrith, Eng.). pp 180-94 of Physics of Fast Reactor Operation and Design. London; British Nuclear Energy Society (1969).

From International Conference on the Physics of Fast Reactor Operation and Design, London, England. See CONF-690634.

In order to make full use of integral measurements in the prediction of fast reactor properties it is necessary to deduce from these measurements the best estimate of the cross-section data to be used in calculations, taking into account the uncertainties in both the integral measurements and the basic cross-section data. Methods of adjusting cross-sections to give the best fit to integral measurements are described. The accuracy of the predictions of reactor properties calculated using adjusted cross-sections is analyzed. In particular, the accuracies of predictions of properties of the U. K. prototype fast reactor are estimated. The major adjustments to the differential data required to fit integral measurements of reactivity, reaction rate ratios and neutron spectrum are identified. The unadjusted data are taken from the fine group library FGL4, the origins of which are described. The cell codes FRESCO and MURAL, which are used to calculate the integral properties, are also described. (auth) (UK)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 20992, 21336, 21337, 21345, 21396, 21397, 21409, 21418, and 21443–21445.

22509 (AERE-R-6264) THE EFFECT OF BURNUP ON THE O/M RATIO OF IRRADIATED $(U,Pu)O_2$ AND PuO_2. Davies, J. H.; Ewart, F. T.; Taylor, R. G. (Atomic Energy Research Establishment, Harwell (England)). Dec 1969. 14p. Dep. CFSTI (U. S. Sales Only). UK 4s.

Pu-bearing oxide fuels are predicted to become increasingly oxidizing with burnup because of a lack of balance between O_2 liberated by fission and the fission products. The oxygen "excess" in initially stoichiometric $(U,Pu)O_2$ and PuO_2 was measured as a function of burnup using a CO/CO_2 gas equilibration method. There was a clear trend of increasing O/M with burnup, in fair agreement with predictions, but scatter in the data precluded a detailed test of the assumptions on which the predictions were based. The distribution of the O_2 "excess" in an operating fuel element is discussed. 12 references. (auth) (UK)

22510 OPERATION AND CONTROL OF ON-LINE COMPUTERS. Sanchez-Izquierdo, Jesus (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 13: 417-29(Sep-Oct 1969). (In Spanish).

The basic characteristics and functions performed by on-line digital process computers for nuclear installations are discussed, and general systems for data acquisition and handling are described. Advantages and disadvantages of on-line digital systems are examined, and examples of practical application of various systems are described. 17 references. (H.D.R.)

22511 CALCULATION OF FABRICATION COSTS OF FUEL ELEMENTS. Clement, J. M.; Iglesias, T.; Diaz, J. D. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 13: 407-15(Sep-Oct 1969). (In Spanish).

The extrapolation of laboratory or pilot plant data on reactor fuel element fabrication to an industrial scale is greatly complicated by the numerous variables involved. The HALCON program for use with the UNIVAC computer of the Junta de Energia Nuclear was developed for calculating fuel element fabrication costs. The basic principles of calculation and the general outline of the program application are presented. 6 references. (H.D.R.)

22512 APPARATUS FOR NUCLEAR REACTOR CONTROL. Sidall, E. (to Atomic Energy of Canada Ltd.). Canadian Patent 830,697. 23 Dec 1969.

A shutdown control assembly for a nuclear power reactor is described which consists of a U-shaped conduit disposed within the core and a reservoir containing a neutron absorbing "ink" positioned above the core and communicating with one end of the conduit. There are also a connecting pipe between the reservoir and the other end of the conduit, a trip valve for releasing the "ink" for reactor shutdown, and a restricted tube connecting the conduit with the reservoir. A pump connects the conduit with the reservoir for slowly returning the "ink" from the conduit to the reservoir during controlled startup. (F.S.A.)

22513 REACTOR JACKET. Boettcher, A. (to Kernforschungsanlage Julich GmbH). Canadian Patent 832,845. 27 Jan 1970. Priority date 1 Sep 1966, Germany.

An improved method of enclosing the fuel in a reactor so as to avoid contamination of the coolant with fission products is described. The sealed apparatus consists of a metallic can with the ends provided with a pair of metallic closure caps secured to the can in spaced relationship. The pair of caps is secured to the can at seams formed by brazing or welding in such a way that the coolant is capable of contacting only one cap of the pair and its associated seam. The object of this special welding closure with double caps is to ensure the integrity of the fuel from contact with the coolant. (F.S.A.)

22514 METHOD OF REPLACING SUBASSEMBLIES IN NUCLEAR REACTORS. Yevick, John G.; Brill, Edward F. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,503,849. 31 Mar 1970. Filed 30 Oct 1967.

A method of replacing a subassembly in a nuclear reactor is described. The device consists of a subassembly handling mechanism on top of the main plug and a preselected liner tube. The device removes a small top plug from engagement with the top of the main plug by a gripper cable mechanism and positions the subassembly handling mechanism. A new subassembly is then lowered into the liner tube. The next steps are: retaining the new subassembly inside the liner tube in a decay region, removing a hot subassembly from the core of the reactor and placing it in the decay region adjacent the new subassembly, placing the new subassembly in the reactor core, removing a decayed subassembly which has been retained in the decay region since the last refueling operation, returning the small plug from the subassembly handling mechanism to its engaged position on top of the main plug, and removing the subassembly handling mechanism. (Offic. Gaz.)

22515 NUCLEAR FUEL ELEMENT. Lerouge, Georges; Viallet, Hubert (to Commissariat a l'Energie Atomique). British Patent 1,185,816. 25 Mar 1970. Priority date 22 Mar 1968, France.

REACTOR FUEL ELEMENTS — description of metal clad tube shaped, with central graphite rod and metal end caps (D.C.C.)

22516 NUCLEAR REACTOR CONTAINMENT VESSELS AND METHODS OF CONSTRUCTING SUCH VESSELS. (to Stone and Webster Engineering Corp.). British Patent 1,185,459. 25 Mar 1970. Priority date 29 Mar 1968, United States.

REACTOR CONTAINMENT STRUCTURES — construction of cylinder shaped multiple zone prestressed concrete (D.C.C.)

GENERAL

22517 (BNWL–1283) ULTRASONIC REFLECTION AND TRANSMISSION FACTORS FOR MATERIALS WITH ATTENUATION. Becker, F. L.; Fitch, C. E.; Richardson, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 92p. Dep. CFSTI.

22518 (COO–499-22) ION-EXCHANGE SEPARATION OF SILVER AND LEAD. Grays, Harovel; Walton, Harold F. (Colorado Univ., Boulder). [13 Mar 1970]. Contract AT(11-1)-499. 6p. Dep. CFSTI.

22519 (COO–913-39) NOTE ON RADIATIVE TRANSITIONS. Lipsky, Sanford (Minnesota Univ., Minneapolis. Dept. of Chemistry). 1 Mar 1970. 13p. Dep. CFSTI.

22520 (COO–1029-33) MASS SPECTROMETRIC OBSERVATIONS OF GASEOUS BORON SELENIDES. Melucci, Robert C.; Wahlbeck, P. G. (Illinois Inst. of Tech., Chicago. Dept. of Chemistry). [2 Feb 1970]. Contract AT(11-1)-1029. 12p. Dep. CFSTI.

The vapor species evaporating from a sample prepared to be B_2Se_3 were identified with a time-of-flight mass spectrometer. The sample was heated to progressively higher temperatures over the range from ca. 100°C to ca. 700°C. The sample was contained in a tungsten Knudsen cell. Parent gaseous species believed to be present were $BSe_2(g)$ and $B_2Se_3(g)$. In addition there were products from the hydrolysis reaction with the condensed B_2Se_3 phase. These results are compared with those for the B–S system by Gilles et al. The B–S and B–Se systems show similar vaporization behavior; the principal difference observed was the absence of gaseous polymers of BSe_2 and B_2Se_3. (auth)

22521 (COO–1469-150) LINE AND AREA ORTHOGONALITY OF JACOBI POLYNOMIALS. Report No. 369. Chawla, M. M.; Jain, M. K. (Illinois Univ., Urbana. Dept. of Computer Science). Dec 1969. Contract AT(11-1)-1469. 12p. Dep. CFSTI.

22522 (COO–1469-155) QUARTERLY TECHNICAL PROGRESS REPORT, OCTOBER–DECEMBER 1969. (Illinois Univ., Urbana. Dept. of Computer Science). 241p. (COO–1018-1196). Dep. CFSTI.

22523 (COO–1711-9) ENERGY EXCHANGE WITHIN ECOSYSTEMS. Third Annual Technical Progress Report, May 15, 1969–May 14, 1970. Gates, David M. (Missouri Botanical Garden, St. Louis). Contract AT(11-1)-1711. 12p. Dep. CFSTI.

22524 (COO–1714-6) THEORY OF THE PRE-EXPONENTIAL FACTOR IN ORGANIC SEMICONDUCTORS. Kemeny, Gabor; Rosenberg, Barnett (Michigan State Univ., East Lansing). [1969]. 13p. Dep. CFSTI.

22525 (COO–1714-7) THE NATURE OF THE CHARGE CARRIERS IN SOLVATED BIOMACROMOLECULES: DNA AND WATER. Powell, Michael R.; Rosenberg, Barnett (Michigan State Univ., East Lansing. Dept. of Biophysics). [24 Feb 1970]. 10p. Dep. CFSTI.

22526 (CTC–31) A THREE-DIMENSIONAL PLOTTING PACKAGE FOR THE IBM/7090. Hume, Alfred (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 10 Apr 1970. Contract W-7405-eng-26. 43p. Dep. CFSTI.

22527 (EURAEC–2124) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Report 438-20. Quarterly Report No. 20. Clevinger, Gary S. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Jul 1969. Contract AT(40-1)-3208. 26p. Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

22528 (EURAEC–2129) RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Final Report. Report No. 438-F. Clevinger, Gary S. (Virginia Polytechnic Inst., Blacksburg. Dept. of Metals and Ceramic Engineering). Aug 1969. Contract AT(40-1)-3208. 39p. Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

22529 (IS–2082) OPERATION AND MAINTENANCE OF THE AMES SELECTIVE DISSEMINATION OF INFORMATION (SDI) COMPUTER SYSTEM. Watkins, W. J. (Ames Lab., Iowa). Jun 1969. Contract W-7405-eng-82. 51p. Dep. CFSTI.

22530 (LA–4163-TR) REACTION SITES IN CONDENSED-EXPLOSIVE DETONATION WAVES. Buravova, S. N.; Veretennikov, V. A.; Dremin, A. N. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Vzryvnoe Delo, Nauch.-Tekh. Gorn. Obshchest., Sb.; No. 63/20, 56-60(1967). 5p. Dep. CFSTI.

22531 (LA–4313) RESONANCE RADIATION IN ARTIFICIAL STRONTIUM AND BARIUM CLOUDS. Horak, Henry G.; Kerr, Donald M.; Tierney, Martin S. (Los Alamos Scientific Lab., N. Mex.). 10 Nov 1969. Contract W-7405-eng-36. 26p. Dep. CFSTI.

22532 (LA–4340) EQUATION OF STATE OF LOW-DENSITY CARBON. McQueen, R. G.; Carter, W. J. (Los Alamos Scientific Lab., N. Mex.). 20 Jan 1970. Contract W-7405-eng-36. 6p. Dep. CFSTI.

22533 (LA–4380) SCHLIEREN PHOTOGRAPHY: A BIBLIOGRAPHY. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). 11 Mar 1970. Contract W-7405-eng-36. 4p. Dep. CFSTI.

22534 (MHSMP–12) STUDY OF HIGH EXPLOSIVES BY OPTICAL THERMAL ANALYSIS. Faubion, Billy Don (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex.). Sep 1969. Contract DA-11-173-AMC-487(A). 43p. Dep. CFSTI.

22535 (NYO–2150-56) SOLID STATE PHYSICS; MAGNETIC PHENOMENA. Progress Report, January 1–December 31, 1969. Bowers, R.; Silsbee, R. H. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Contract AT(30-1)-2150. 13p. Dep. CFSTI.

22536 (NYO–2391-110) SECOND SOUND IN SOLIDS. Krumhansl, J. A.; Pohl, R. O. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). [1970]. Contract AT(30-1)-2391. 8p. Dep. CFSTI.

22537 (NYO–2598-49) LOSS OF ORGANIC AND INORGANIC MATERIALS FROM ABOVE-GROUND PLANT PARTS BY LEACHING. Progress Report 1969–70. Tukey, H. B. Jr. (Cornell Univ., Ithaca, N. Y. Dept. of Floriculture and Ornamental Horticulture). Feb 1970. Contract AT(30-1)-2598. 12p. Dep. CFSTI.

22538 (NYO–3406-18) PIEZOELECTRIC MECHANICAL-MICROPIPETTE STIMULATOR. Technical Report No. 10. Reynolds, Geo. T. (Princeton Univ., N. J. Elementary Particles Lab.). 12 Feb 1970. Contract AT(30-1)-3406. 12p. Dep. CFSTI.

22539 (NYO–3489-13) CELL COMMUNICATION, Ca^{++}, AND CYCLIC AMP. Rasmussen, Howard (Pennsylvania Univ., Philadelphia. Dept. of Biochemistry). [1970]. 36p. Dep. CFSTI.

22540 (NYO–3859-8) BIOLOGICAL APPLICATIONS OF MOESSBAUER SPECTROSCOPY. Progress Report, February 1969–February 1970. Epstein, L. M.; Straub, Darel K. (Pittsburgh Univ., Pa. Dept. of Chemistry). Contract AT(30-1)-3859. 55p. Dep. CFSTI.

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22558 (SCL-RR-70-38) COMPOSITIONAL DEPENDENCY OF THE PERMEABILITY OF GLASS. Shelby, J. E. (Sandia Labs., Livermore, Calif.). Mar 1970. Contract AT(29-1)-789. 26p. Dep. CFSTI.
The effects of composition on the permeability of glass are discussed. It appears that the modifier content is just as important in determining the permeability of a given glass as is the network former concentration. The effect of hydroxyl content on permeability has not been established adequately, and the status of knowledge in this area is assessed. It was concluded that a systematic study of the effect of composition on permeability is needed to provide a clearer understanding of the mechanisms involved. (auth)

22559 (SLAC-114) AN APL MACHINE. Abrams, Philip S. (Stanford Linear Accelerator Center, Calif.). Feb 1970. Contract AT(04-3)-515. 204p. Dep. CFSTI.

22560 (STAN-CS-70-154) SPECTRUM OF INCORRECTLY DECODED BURSTS FOR CYCLIC BURST ERROR CODES. Stone, Harold S. (Stanford Univ., Calif. Dept. of Computer Science). Jan 1970. Contract AT(04-3)-326. 24p. Dep. CFSTI.

22561 (TID-3757) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period January-February 1970. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 7p. Dep. CFSTI.
A list of 41 bibliographies of atomic energy literature issued or in progress during January-February, 1970, is presented. A report number index is included. (W.H.K.)

22562 (TID-25376) A TOPOLOGICAL STUDY OF THE SINTERING PROCESS. Final Report, June 1959-May 1969. Rhines, F. N.; DeHoff, R. T.; Kronsbein, J. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). Dec 1969. Contract AT(40-1)-2581. 165p. Dep. CFSTI.

22563 (TID-25378) THE ORIGIN, STRUCTURE, AND PROPERTIES OF MELANOSOMES IN THE EYES OF AMPHIBIAN LARVAE. Eppig, John J. Jr. (Catholic Univ. of America, Washington, D. C.). 1970. 58p. Dep. CFSTI.
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22564 (UCLA-12-769) INCREASED INCIDENCE OF LYMPHOMA IN C3H/HeJ ADULT MICE INJECTED WITH GROSS VIRUS AND ANTITHYMOCYTIC SERUM. Vredevoe, Donna L.; Hays, Esther F. (California Univ., Los Angeles). [1970]. Contract AT(04-1)-Gen-12. 17p. Dep. CFSTI.

22565 (UCLA-12-770) LOW-TEMPERATURE CIRCULAR DICHROISM OF TYROSYL AND TRYPTOPHANYL DIKETOPIPERAZINES. Strickland, E. Hardin; Horwitz, Joseph; Billups, Carolyn (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology); Wilchek, Meir (Weizmann Inst. of Science, Rehovoth (Israel)). [1970]. Contract AT(04-1)-Gen-12. 60p. Dep. CFSTI.

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22568 (UCRL-50782) METHOD FOR EVALUATION AND CERTIFICATION OF THE FERRANTI X-Y COORDINATE MEASURING MACHINE. Lane, Donald L. (California Univ., Livermore. Lawrence Radiation Lab.). Nov 1969. 25p. Dep. CFSTI.

22569 (UCRL-50814) A DISPLACEMENT BEAM TRANSDUCER FOR MEASURING LARGE DISPLACEMENTS AT HIGH-VIBRATION FREQUENCIES. Hassett, Scott E. (California Univ., Livermore. Lawrence Radiation Lab.). 24 Feb 1970. 8p. Dep. CFSTI.

22570 (WAPD-TM-731) GAPL-1: A COMPUTER PROGRAM FOR THE PLASTIC STRESS ANALYSIS OF A HORIZONTAL PLATE WITH PRESSURE LOADING ABOVE AND DEFLECTION RESTRAINTS BELOW. Friedrich, C. M.; Guilinger, W. H.; Sumner, A. E. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan 1970. Contract AT(11-1)-Gen-14. 51p. Dep. CFSTI.

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22572 (Y-1706) PREPARATION AND PROPERTIES OF CARBON FOAM. Sands, A. E.; Scrivner, M. E.; Paluzelle, R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 23 Mar 1970. Contract W-7405-eng-26. 50p. Dep. CFSTI.

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